New York and Westinghouse AIR BRAKES

By CHAS. McSHANE

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Preface.

This is a new book on the subject of air brakes. The publishers' aim has been to give a clear exposition of both the New York and Westinghouse systems, without prejudice to either brake, in a concise and compact form for use at home and on the road. The work has been thoroughly examined and approved by a number of practical men as shown by the title page and, we believe, a careful study of the same will enable the reader to successfully handle either brake. The publication of this book was delayed by the death of the author, Mr. Chas. McShane, and it is now edited by Mr. John T. Hoar of the Pennsylvania Railway Company. A carefully prepared index will be found at the end of the book.

THE PUBLISHERS.

Chicago, Ill., January 25, 1905.

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NEW YORK AND WESTINGHOUSE AIR BRAKES

AUTOMATIC QUICK ACTION COMPRESSED AIR BRAKES.

So general has become the use of automatic air brakes on both passenger and freight trains for the purpose of bringing them from high speeds to a state of rest, or while on descending grades, to control their speed, that there is no railway employee whose duties require him to assist in the movement of trains but must possess a general knowledge of this most efficient stopping device in order to discharge those duties satisfactorily. The purpose of this work on the air brake is, therefore, to treat in a general way those points of air brake practice which are essential in the every day safe movement of trains.

Although numberless forms of compressed air brakes have been invented and tried, but two types have survived the ordeal of the exacting requirements of modern railway service, and these types are the Westinghouse and the New York, now both well known to all railroad men because of their almost universal adoption as the controlling power for fast and heavy trains.

ESSENTIAL PARTS OF THE AIR BRAKE.

The automatic quick-action compressed air brake consists essentially of an *air pump*, or *compressor*, whose duty is to pump the air from the surrounding atmosphere, and to compress it into the reservoirs and the pipes, to the required pressure.

A *main reservoir* which is generally located on the engine behind the cylinder saddles, but which may be located elsewhere about the engine or tender, if the space behind the cylinder saddles be not available, and which is made as large as the space in which it is located will permit;

An *engineer's brake* and *equalizing discharge valve* with which the engineer controls the operation of the brakes, located in the cab of the locomotive so as to be within easy reach;

A *triple valve* of which there are two types, the plain and the quick-action;

An *auxiliary reservoir* to hold the supply of air to be used in applying the brakes;

A *brake* cylinder, with a piston and rod in it, in which the braking-pressure is utilized; and the *necessary* pipes, which connect the air pump to the main reservoir, the main reservoir to the engineer's brake valve, the engineer's brake valve to the triple valve, the triple valve to the auxiliary reservoir, and to the brake cylinder.

In addition to the above there is supplied a *pump* governor to control the pump automatically, and prevent too high accumulation of air-pressure in the main reservoir and the train pipes; *an air gauge,* generally of the duplex pattern, for registering the main reservoir and the train-pipe pressures; *a conductor's valve* placed in all passenger equipment, and nowadays being extensively applied to the caboose cars of freight trains, for the purpose of placing the control of the brakes in the hands of the train crew as well as in the hands of the engineer; *flexible hose* and *air tight* couplings for uniting the train pipes of adjoining cars, and for making them continuous throughout the train; *angle cocks,* one of which is placed in each end of the train pipe, for the purpose of closing the ends of this pipe when necessary, as in uncoupling or parting cars. *Cut out cocks* which are placed in that portion of the train pipe, called the branch, or cross-over pipe, and in the train pipe just beneath the engineer's brake valve, for the purpose of cutting out individual defective brakes without interfering with the operation of the other brakes on the same train, and, in cases of double heading, to cut out the brake valve on one engine; a *release valve,* placed in the auxiliary reservoir for the purpose of releasing individual brakes whenever, from any cause, the brake does not release in the usual manner; and the *pressure-retaining valve,* which is applied to all freight cars, and in a great many instances to passenger cars, for the purpose of assisting the brakes to make safe descents on long, heavy grades.

Of the foregoing parts, constituting the air brake apparatus, those of the New York type which differ in form or construction from those of the Westinghouse, that perform similar duties, are the air pump, the pump governor, the engineer's brake valve, and the plain and the quick-action triple valves and the pipe strainer and drain cup. All other parts are alike in form and construction, and *all corresponding parts of both* types perform the same duties.

The pipe which connects the air pump to the main reservoir is generally called the *discharge* pipe; that which connects the main reservoir to the engineer's brake valve, the *return* pipe; while the pipes which connect the brake valve to the triple valve are called the *train* pipe and the *branch* pipe, the branch pipe connecting the train pipe to the triple valve.

The pressure used to operate the brake is, of course, that of compressed air, but in order to discharge the air-pressure contained in one part of the apparatus from that contained in another, and to describe with ease and certainty the function of the air-pressure in its passage through the air brake system, certain divisions are made, and names used to designate them.

NAMES OF DIFFERENT PRESSURES.

Referring to Plates 1 and 2, the pressure contained in that portion of the air brake apparatus between the final discharge valve of

PLATE I.


AUXILIARY RESERVOIR
DRAIN COCK
SLACK ADJUSTER
CAR BRAKE CYLINDER
CONDUCTOR'S VALVE
QUICK-ACTION TRIPLE VALVE
CUT-OUT COCK
ANGLE COCK
ANGLE COCK
TRAIN PIPE
AIR STRAINER
HOSE
HOSE COUPLING
HOSE
PASSENGER-CAR EQUIPMENT
SLACK ADJUSTER
TENDER BRAKE CYLINDER
AUXILIARY RESERVOIR
PLAIN TRIPLE VALVE
DRAIN COCK
CUT-OUT COCK
ANGLE COCK
ANGLE COCK
HOSE
HOSE COUPLING
HOSE
TRAIN PIPE
TENDER
DRAIN CUP
DRAIN COCK
ANGLE FITTING
TENDER EQUIPMENT
HOSE
HOSE COUPLING
HOSE
ANGLE FITTING
GAUGE
COPPER PIPE
ONE-INCH PUMP GOVERNOR
NINE AND ONE-HALF-INCH AIR PUMP
ENGINEERS BRAKE VALVE
TO BOILER
EXHAUST
SERVICE DISCHARGE
EQUALIZING RESERVOIR
DRAIN COCK
CUT-OUT COCK
MAIN RESERVOIR
OIL CUP
DRAIN COCK
AIR STRAINER
ENGINE EQUIPMENT


AUXILIARY RESERVOIR
SLACK ADJUSTER
BRAKE CYLINDER
QUICK ACTION TRIPLE VALVE
CONDUCTORS VALVE
PASSENGER CAR EQUIPMENT.
ANGLE COCK
ANGLE COCK
CAR DRAIN CUP
TRAIN PIPE
HOSE
COUPLING
HOSE
PLAIN TRIPLE VALVE
AUXILIARY RESERVOIR
BRAKE CYLINDER
SLACK ADJUSTER
TENDER EQUIPMENT.
CUT OUT COCK
TRAIN PIPE
TENDER DRAIN CUP
HOSE
COUPLING
HOSE
HOSE
COUPLING
HOSE
SUPPLEMENTARY RESERVOIR
ENGINEERS BRAKE VALVE
STOPCOCK.
MAIN RESERVOIR
DUPLEX AIR PUMP
ENGINE EQUIPMENT
TO BOILER
GOVERNOR
EXHAUST

the air pump and the excess-pressure valve in the engineer's brake valve, comprising the discharge pipe, the main reservoir and the return pipe, is called *main-reservoir* pressure; that between the excess pressure and feed valves, and the triple-piston valve, in the triple-valve body, is called the *train-pipe* pressure; that contained in the auxiliary reservoir and the triple-exhaust valve, or slide valve chamber, is called the *auxiliary reservoir* pressure; and that between the face of the exhaust valve and the brake cylinder piston is called the *brake cylinder* pressure.

The *excess-pressure* is the amount of pressure contained in the main reservoir over that contained in the train pipe.

There is also frequently used, in discussing air brake matters, the terms *atmospheric-pressure* and the *vacuum*.

Atmospheric-pressure is the ordinary pressure of free air, so called, at the level of the sea, and it is equal to 14.7 pounds per square inch.

A *vacuum* is present in a cylinder or any closed vessel which can be made air-tight, when there is no pressure whatever in it, or when the pressure is zero or nothing. Mr. Gesner says: "A still better definition of the word *vacuum* is 'space devoid of all matter.'"

ARRANGEMENT OF APPARATUS.

Reference to Plates 1 and 2 shows that the general arrangement of the several parts of both the Westinghouse and the New York apparatus is the same. The air pump, main reservoir, engineer's brake valve, plain triple valve, pump governor, air gauge, and cut-out cock for the engineer's brake valve are the parts that belong especially to the engine equipment. The quick-action triple valve is used on the cars, while the auxiliary reservoir, brake cylinder and all the other parts of the equipment, not named above as being applied specially to the engine, are applied to all engines, tenders and cars.

AIR PUMPS.

The air pumps, or compressors, are of two types, as may be seen from the plates. The Westinghouse pump has a single steam cylinder and a single air cylinder arranged so that the air cylinder is below the steam cylinder when the pump is in its position on the boiler of the locomotive.

The New York air pump is of the duplex type; that is, it consists of two combined steam cylinders and two combined air cylinders, having one air cylinder that has double the cubical capacity of any one of the other three cylinders; and when the pump is in position on the boiler of a locomotive, the air cylinders are above the steam cylinders. The air pumps of both types are so constructed that when steam is admitted to the steam head of the pump it is distributed to the upper and lower sides of the steam pistons by means of suitably constructed reversing valve gear to provide for the up and the down strokes of the pistons. The pistons are combined steam and air pistons; that is, there is a steam piston head on one end of the piston rod and an air piston head on the other, so that when the steam piston makes a stroke the air piston also makes a stroke.

In the air cylinders of the pumps are suitably arranged air valves for the admission of air from the atmosphere to the air cylinder, as the air piston moves in one direction, and the discharge of this air into the main reservoir, as it is compressed by the air piston when moving in the opposite direction.

In the Westinghouse pump there are four air valves, two receiving and two discharge; in the New York pump there are six air valves, two receiving, two combined intermediate receiving and discharge, and two final discharge valves.

At each stroke made by the Westinghouse pump, the air received on the previous stroke is discharged direct into the discharge pipe and the main reservoir, while the New York pump discharges all the air, received in the large air cylinder, into the small air cylinder, and the latter then discharges into the main reservoir all the air received from the large air cylinder and from the atmosphere direct.

The reversing valve gear for the Westinghouse 9½-inch pump consists of a slide valve, held between pistons of unequal diameter; a reversing slide valve, a tappet rod, working in a hollow piston rod and a reversing tappet rod plate bolted to the steam piston head.

As the steam piston approaches the end of its stroke it alternately pulls and pushes the tappet rod and reversing slide valve up and down, thus alternately admitting steam through suitably arranged ports in the reversing valve seat to and exhausting it from, one side of the large differential piston head, and in this way provides for the movement of the main slide valve, which alternately opens and closes the steam and exhaust ports to the upper and lower ends of the steam cylinder.

The reversing valve gear for the New York pump consists of two ordinary D slide valves, two tappet rods, and two reversing tappet rod plates, bolted to the steam piston heads. Each piston rod is made hollow on its steam end, and the tappet rods work in the hollow portion of each piston rod, and each tappet rod has one D slide valve attached to its lower end which is moved up and down together with the tappet rods and in so moving opens and closes the steam and exhaust ports in their bushings leading to the upper and the lower ends of the steam cylinders.

From the figure of the duplex pump it will be noticed that the steam ports are crossed; that is, that the steam ports in the pump head directly under one steam cylinder lead to the other steam cylinder, and from this it will be learned that the steam piston, tappet rod, etc., of one steam cylinder move the slide valve under it so as to admit steam to and exhaust it from the other steam cylinder, and that when one piston has made a stroke, it must wait until the other makes a stroke before it can make its return stroke. On account of one of the air cylinders being made so as to have twice the cubical capacity of the other, the duplex pump will economize in the use of steam, as three measures of air are compressed for each two measures of steam used.

The main reservoir is intended to hold in storage a large volume of compressed air for releasing the brakes, and recharging the auxiliary reservoirs and the train pipe. It also acts as a catch basin or trap for all moisture and dirt that may be contained in the air as it leaves the pump. Mr. Gesner adds: "It should always be placed below the pump in the air brake system and the larger it can be made the better it will fulfill its proper functions."

THE ENGINEER'S BRAKE VALVE.

The Engineer's Brake and Equalizing Discharge valves of the Westinghouse and the New York types differ largely in their construction and appearance, but perform the same functions in nearly the same manner.

The principal valve in the Westinghouse engineer's brake valve is called the *rotary,* because of its rotary motion when in operation. There is a secondary valve called the equalizing discharge valve, which has a piston, attached to one end of its stem.

The equalizing discharge piston under normal conditions is balanced between the train-pipe pressure, bearing upwards from beneath, and the equalizing reservoir pressure bearing downward on the top.

The equalizing feature of the brake valves operate in all service applications, but not in emergency applications.

In the New York engineer's brake valve the principal valve is a slide valve, as is also the secondary or graduating valve.

The graduating valve is moved by means of an air tight piston, acted upon by pressure in the supplementary reservoir, and a lever connecting the equalizing discharge piston and graduating valve.

The equalizing discharge piston is exposed to train pipe pressure in front of it, and supplementary reservoir pressure behind it.

The difference in operation of the two types of brake valves consists in the way in which the train pipe reduction is made and gradually closed off in the service application. In the Westinghouse the required service reduction in train-pipe pressure is accomplished by moving the handle of the brake valve to the service position, and reducing the *equalizing reservoir* pressure the required amount, and then returning the handle to the lap position.

The pressure in the train pipe (the moment it is greater than in the equalizing reservoir) will raise the equalizing discharge piston and valve, and permit the train pipe-pressure to escape to the atmosphere, gradually moving back to its seat as the pressure in the train pipe falls to an amount equal to that remaining in the equalizing reservoir. The service reduction in train pipe pressure is made with the New York brake valve by placing the handle in one of the service graduating notches and allowing it to remain there until the train pipe exhaust closes.

As the train pipe pressure reduces in front of the equalizing discharge piston, the pressure in the supplementary reservoir pushes the equalizing piston forward until the graduating valve covers the service port in the main slide valve.

By referring to the cuts, a view of the external appearance and of the interior construction of the respective brake valves may be obtained, and from them it will be seen that the handle of one is moved in a horizontal plane, and the handle of the other in a vertical plane, to apply and to release the brakes.

PLAIN TRIPLE VALVES.

The plain triple valves are shown in Figs. 1, 2 and 3. They consist of a triple piston;

a slide (or exhaust) valve; and a graduating valve, enclosed in suitable cylinders and bushings that are securely pressed into the cast iron body.

The Westinghouse triple piston has a varying stroke, depending on whether it is a slow and graduating application of the brake that is required, as in making ordinary station stops, or quick application, such as is required in emergencies; while the New York triple piston valve Fig. 2, has the same stroke in both the service and the emergency applications.

The essential parts of the plain triple valve in either type are, first, a triple piston; second, a slide valve; and third, a graduating valve.

These parts are enclosed in the body of the triple, that portion in which the triple piston operates being of cylindrical form, with a short groove, called the feed groove, cut in the upper forward extremity; and that portion in which the slide and graduating valves move being formed so as to provide an air tight seat for those valves.

As the air pressure flows into the train pipe from the engineer's brake valve it presses against one side of the triple piston and moves it along, with the slide and the graduating valve, to the release position, as shown in the cuts, and when in this position the small feed groove, spoken of above, in the triple cylinder is uncovered, and the air flows through it to the auxiliary reservoir,

WESTINGHOUSE PLAIN TRIPLE VALVE.

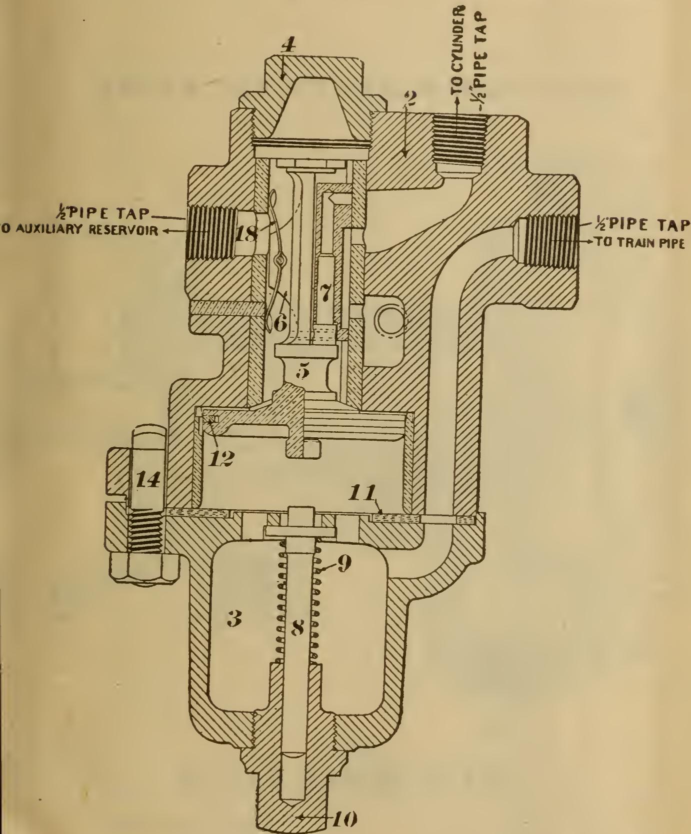


Fig. 1.

PLAIN TRIPLE VALVE.

2 Triple valve body.
3 Cylinder cap.
4 Cap nut.
5 Piston.
6 Slide valve.
7 Graduating valve.
8 Graduating stem.
9 Graduating-stem spring.
10 Graduating-stem nut.
11 Cylinder gasket.
12 Packing ring.
14 Bolt.
18 Slide valve spring.

NEW YORK PLAIN TRIPLE VALVE.

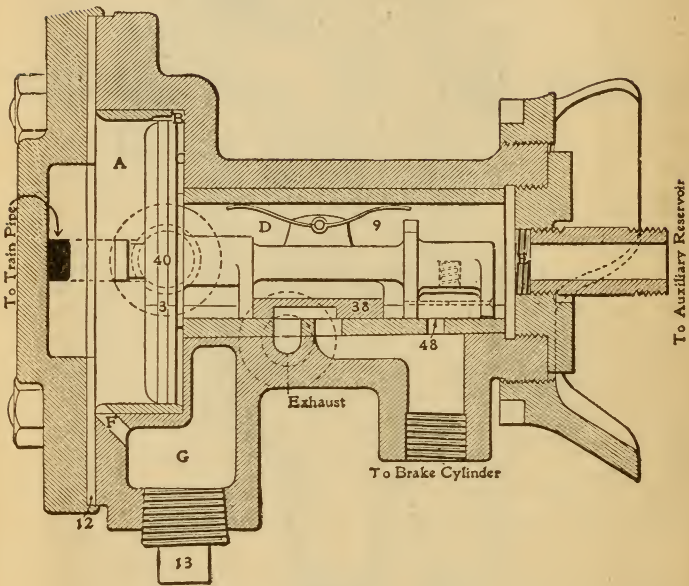


Fig. 2.

PLAIN TRIPLE VALVE.

3	Piston ring.	26	Cap bolt.
9	Slide valve spring.	27	Triple valve body.
11	Cap.	29	Plug.
12	Gasket.	38	Slide valve.
13	Drain plug.	40	Piston.
14	Bracket.	48	Graduating valve.
16	Nipple.	49	Graduating valve spring.

charging the latter to the same pressure as is contained in the train pipe.

When, therefore, a reduction, either graduated or quick, is made from any cause in the train pipe pressure, the greater pressure which then remains in the auxiliary reservoir will move the triple valve (the triple piston, the triple slide, and the graduating valves combined) in the direction of the weaker (train pipe) pressure, the triple piston first moving a sufficient distance to close the communication, through the feed groove, between the train pipe and the auxiliary reservoir, then moving the slide valve to a position closing the communication, called the exhaust port, between the brake cylinder and the atmosphere, and the graduating valve to a position uncovering the service port in its seat, leading from the auxiliary reservoir to the brake cylinder. Through the service port, when open, the auxiliary reservoir pressure will expand into the brake cylinder, and force the brake cylinder piston out, and thus by means of the connected foundation brake rigging, apply the brakes.

It will be seen from the foregoing and from a careful study of the figures that after once the auxiliary reservoirs are charged up equal to the train pipe, that any ordinary reduction of four or more pounds in train pipe pressure, from any source, will operate the triple valves, and apply the brakes. Mr. Roach adds: "If the reduction be large enough. For this reason the triple valve is considered the most important part of the air brake apparatus, and it is due to its peculiar construction that the air brake is automatic or self-acting. The new style New York triple valve is shown by Fig. 3 The operations of this valve are the same as those previously described. This is a special driver brake triple and is used only with 12-inch, 14-inch and 16-inch driver brake cylinders.

The quick action triple valve differs from the plain triple in that it has a set of additional valves which are so arranged in the body of the triple that they lie inactive during a gradual reduction in train pipe pressure, but whenever a quick reduction is made in the train pipe pressure they go into action instantly, and in so doing vent the train pipe air locally into the brake cylinder or into the atmosphere—into the brake cylinder if it is a Westinghouse triple and into the atmosphere, if it is a New York triple.

The reason for venting the train pipe air locally either to the brake cylinder or to the atmosphere, is to hasten the reduction in the train pipe pressure throughout the whole length of the train pipe on long trains that all the brakes may be applied almost instantly, and thus in emergencies bring the train to a stop in the shortest time and distance, and also to avoid the shock to the rear end of the train that would be had if any considerable time should elapse between the application of the brakes on the front and on the

NEW STYLE PLAIN TRIPLE.

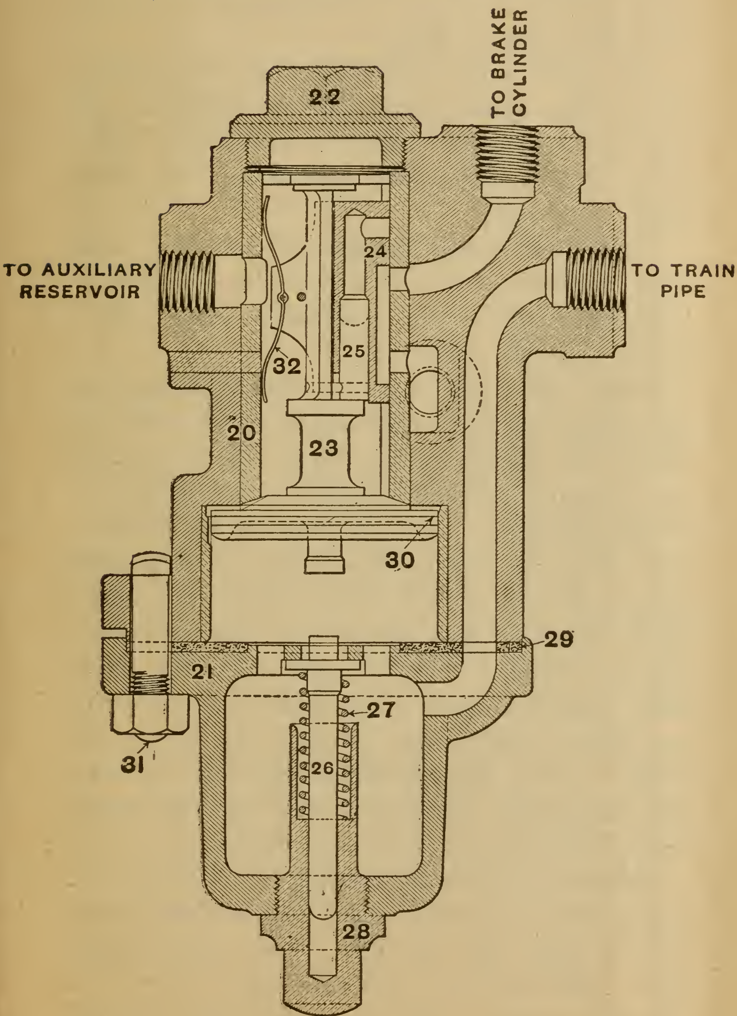


Fig. 3.

rear of the train, owing to the slack in the train allowing the rear cars to run in against the heavily braked cars in front.

The quick action mechanism of the Westinghouse triple valves consists of an emergency piston, an emergency valve, a non-return check valve, and an emergency port in the seat of the triple slide valve.

The quick action feature of the New York triple consists of a vent valve, a vent piston, an emergency piston, an emergency valve, and a brake cylinder check valve.

When the triple valve of the Westinghouse type makes its full stroke the slide valve will uncover the emergency port in its seat and permit the auxiliary reservoir pressure to flow to the top of the emergency piston, forcing the latter downward which in turn by reason of its stem bearing against the emergency valve forces this valve away from its seat, when train pipe pressure, which is always directly underneath the emergency valve, can flow to the brake cylinder. The non-return check valve prevents the air in the brake cylinder from flowing back into the train pipe, should the pressure in the train pipe be reduced below that in the brake cylinder.

The quick action mechanism of the New York triple valve is put into action by a sudden reduction in train pipe pressure. Between the main triple piston and the vent valve piston there is a chamber charged with air to the same pressure as that in the auxiliary and in the train pipe, which, when a gradual reduction is made in the train pipe pressure, can reduce at the same rate along with it and thus allow the triple valve to move without disturbing the vent valve. But when a quick reduction in train pipe pressure is made, causing a quick movement of the triple valves, the triple piston of the latter cushions on the air in the vent-piston chamber and forces the vent piston along in the same direction. The stem of the vent piston strikes against the lever arm of the vent valve, forcing the latter away from its seat and it thus permits the train pipe pressure, which is behind it to escape to the vent passage, formed in the triple around through the body leading to the emergency piston.

As the air thus vented into the emergency passage, rushes toward the outlet, it is directed against the emergency piston forcing it over against the emergency valve, forcing the latter away from its seat, and then it escapes to the atmosphere through the vent ports at the side of the triple body under the emergency cap.

Behind the emergency valve we have auxiliary reservoir pressure, and as this valve is forced back from its seat the auxiliary pressure flows into the brake cylinder, through the passage leading thereto through the body of the triple, forcing from its seat, as it does so, the brake cylinder check valve, which seats after the auxiliary reservoir pressure has entered the brake cylinder.

The brake cylinders are constructed in the ordinary way of cast iron, and are bored out so as to have a perfectly cylindrical and smooth interior surface. The brake cylinder piston is made so as to fit the brake cylinder air tight, the air tight joint being formed by a packing leather which is held securely on the piston rod by a follower plate and four bolts. Mr. Gesner adds: "and an expanding ring."

All brake cylinders, auxiliary reservoirs, angle cocks, cut-out cocks, conductor's valves, release valves, and pressure retaining valves are so near alike in both types of brakes, and so plainly shown by the illustrations as to need no description.

The pump governors of both types of brakes, while somewhat different in construction, in operation they are similar.

They consist essentially of a regulating spring, a regulating screw and nut, an air valve, a governor piston, a steam valve and stem, and a suitable casing and body to enclose those parts, and to form a seat for the steam valve and a steam passage through which the steam can pass to the pump.

The function of the governor is to control the pump in such a manner as to prevent it from accumulating in the main reservoir and the train pipes more than the fixed standard air pressure which it is desired to carry. Mr. Dickson says: "The function of the governor is not to control the speed of the pump, but to start and stop it. The pump throttle regulates its speed."

The main reservoir pressure operates the pump governor, with the Westinghouse brake valve except when the old style D 8 valve is used. With the D 8 brake valve the train pipe pressure operates the governor. With the New York brake valve the train pipe pressure operates the governor. Therefore, in one the tension of the regulating spring is adjusted to withstand a pressure of ninety pounds which is the main reservoir pressure generally carried; and in the other the tension of the regulating spring is adjusted to withstand a pressure of seventy pounds, the standard train pipe pressure.

With either governor, when the air pressure for which it is adjusted is attained, the regulating spring is compressed, and a diaphragm which forms an air tight separation between the regulating spring casing and the air chamber beneath it, is raised from its seat, or as in the case of the Westinghouse governor, it and the pin valve along with it, is raised, opening a communication with the chamber above the governor piston through which air can flow to the top of the latter and force it together with the steam valve and stem, downward, until the steam valve seats and shuts off the steam to the pump, thus slowing the latter down to a very slow rate of speed.

As soon as the air pressure falls below that for which the governor is adjusted, the diaphragm, if the New York, or the diaphragm and pin valve, if it is in the Westinghouse, will seat and close the passage leading down to the governor piston. Then the air on top of the governor piston will quickly escape to the atmosphere and allow the pressure on the top of the governor piston to fall to zero, after which the steam pressure under the steam valve will raise the latter, together with the governor piston, and thus steam will again be admitted to the pump and the latter will start up promptly.

In the construction of these pump governors, the aim has been to make them as sensitive to slight variations in the air pressure as it was possible to make them; this in order that the pumps may be allowed to run slowly but a very short time at each operation of the governor.

In Figs. 23 and 24, pages 84 and 86 the internal construction of the governors are shown and all parts numbered and named for easy reference.

The air gauges for either type of brake are of the duplex pattern; that is, there are two gauges in one case, one gauge to indicate the train pipe pressure, and one to indicate main-reservoir pressure.

The *black* hand on the air gauge indicates train pipe pressure, and the *red* hand, main-reservoir pressure.

WESTINGHOUSE EIGHT-INCH AIR PUMP.

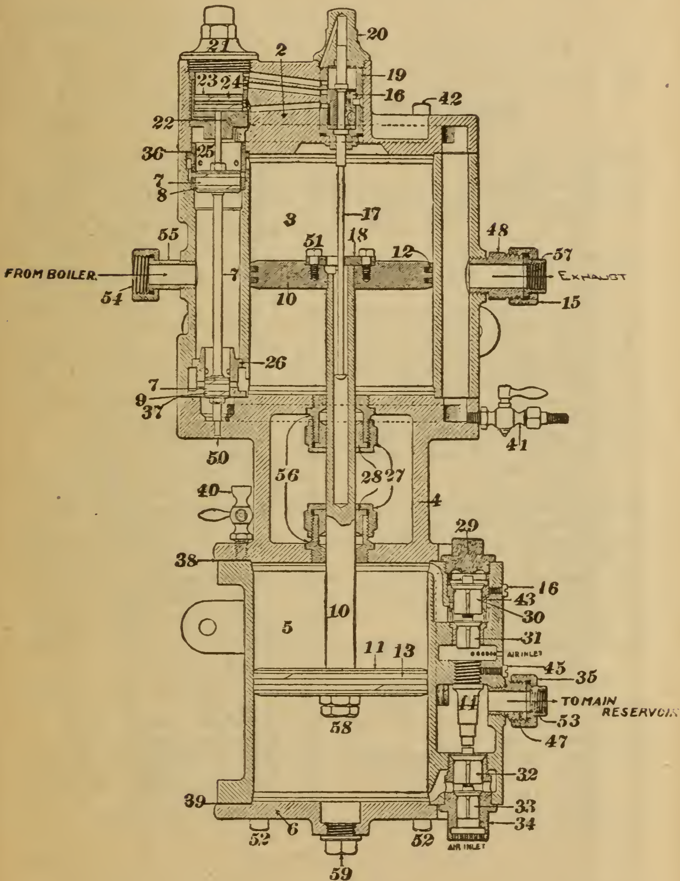


Fig. 4.

EIGHT INCH AIR PUMP.

2 Top head.
3 Steam cylinder.
4 Center piece (forms lower steam head and upper air head).
5 Air cylinder.
6 Air cylinder head.
7 Main valve.
8 Upper main valve packing ring.
9 Lower main valve packing ring.
10 Steam piston and rod.
11 Air piston.
12 Steam piston packing ring.
13 Air piston packing ring.
15 One-inch exhaust pipe union nut.
16 Reversing valve.
17 Reversing valve stem.
18 Reversing valve plate.
19 Reversing valve bush.
20 Reversing valve chamber cap.
21 Reversing cylinder cap.
22 Reversing cylinder
23 Reversing piston.
24 Reversing piston packing ring.
25 Upper main valve bush.
26 Lower main valve bush.
27 Packing nut.
28 Packing gland.
29 Upper valve chamber cap.
30 Upper discharge valve.
31 Upper receiving vaive.
32 Lower discharge valve.
33 Lower receiving valve.
34 Lower valve chamber cap.
35 Three-fourths-inch reservoir-union nut.
36 Upper steam cylinder gasket.
37 Lower steam cylinder gasket.
38 Upper air cylinder gasket.
39 Lower air cylinder gasket.
40 Air cylinder oil cup.
41 Drain cock.
42 Cylinder head bolt.
43 Valve chamber bush.
44 Discharge valve stop.
45 Valve stop set screw.
46 Chamber bush set screw.
47 Three-fourths inch reservoir union stud.
48 One-inch exhaust pipe union stud.
49 Three-fourths inch steam pipe union stud.
50 Main valve stop.
51 Reversing valve plate bolt.
52 Pump head bolt.
53 Three-fourth inch union swivel.
54 Governor union nut.
55 Governor union stud.
56 Piston stuffing box.
57 One-inch union swivel.
58 Piston rod nut.
59 Cylinder head plug.

EIGHT-INCH PUMP.

Q. In which end of the eight-inch pump is the power used to run it?

A. In the upper or steam cylinder end.

Q. What functions are performed by the lower end?

A. The lower end compresses the air, taken into the air cylinder from the atmosphere, and discharges it into the main reservoir.

Q. Where does the steam first enter the pump?

A. At the steam connection made at the side of the pump, and it fills the steam chamber between the ends of the main steam valve 7.

Q. What duties does the main steam valve perform?

A. The same duties as a slide valve in the steam chest of an engine; it alternately admits steam to the upper, and to the lower end of the steam cylinder; and after this steam has done its work in moving the steam piston, it provides for its escape, or exhaust, to the atmosphere.

Q. When the steam piston is ready to commence its down stroke how is the upper steam port uncovered?

A. The upper piston head of the main steam valve is much larger than the lower, and for this reason the total steam pressure upon it is greater, and forces it upward until the steam port in the upper end of the valve chamber is opened;

admitting steam to the top of the steam piston at the same time that the upper steam port is opened to admit steam to the pump, the lower exhaust ports are open to the atmosphere, permitting the steam used on the up-stroke to exhaust to the atmosphere.

Q. When the down-stroke is completed how is the movement of the piston reversed?

A. As the upper piston of the main valve has a greater area than the lower, and an additional pressure is required to assist the lower piston to move the main valve downward, in order to open the lower steam port, this additional pressure is supplied by piston 23, called the reversing piston, which bears down upon the large piston of the main valve whenever steam is admitted upon top of it. To admit steam to the top of the reversing piston, the reversing slide valve 16 is moved to its lower position by the reversing rod 17, where the small steam port, leading from its chamber to the top of the reversing piston, is uncovered, and steam is admitted to the reversing cylinder. The pressure thus had on the top of the reversing piston acts downward upon the main steam valve, moves the latter down to a position uncovering the steam port to the lower end of the steam cylinder, and at the same time opens the exhaust port at the upper end, permitting the steam to escape to the atmosphere from the upper side of the steam piston 10.

Q. The steam supplied to the reversing cylinder is obtained from where?

A. The steam supplied to the reversing cylinder is admitted to the reversing slide valve chamber through a small port leading from the main valve chamber and located between the ends of the main steam valve. This cylinder is, therefore, filled with steam at the same pressure as the main valve chamber.

Q. When the piston reaches the end of the up-stroke, how is its motion reversed?

A. As the steam piston approaches the end of its up-stroke the reversing valve rod plate engages the reversing valve rod, moving the latter, together with the reversing slide valve, upward. When the reversing slide valve is moved to the upper end of its travel it closes the steam port leading to the reversing valve cylinder and opens the exhaust port leading from the same chamber, allowing the steam on top of the reversing piston to escape to the atmosphere. When the pressure is removed from the top of the reversing piston, and from the top of the larger piston of the main steam valve, the upward pressure on the larger area of this piston will overcome the pressure exerted in the opposite direction on the smaller or lower piston of the same valve, and, in consequence the main valve will move upward, uncovering the steam port leading to the upper end of the steam cylinder, and will open the exhaust port in the lower end of the same cylinder, permitting the steam to escape, and thus the movement of the steam piston will be reversed.

Q. When the steam piston is making the up and the down strokes, what action is taking place in the air cylinder of the pump?

A. As the air piston and the steam piston head are attached to the same rod, one at one end and one at the other, it follows that whenever the steam piston makes a stroke the air piston will make a stroke also. As the air piston moves upward, the lower air receiving valve 33 is raised by atmospheric pressure, and air enters the air cylinder behind the upward moving air piston. At the same time the air contained in the air cylinder, above the air piston, is being compressed and driven out through the upper discharge valve to the main reservoir. On the downward stroke the lower receiving valve closes, and the confined air is compressed and driven out through the lower air discharge valve 32 to the main reservoir, while at the same time the upper discharge valve to the main reservoir is closed, and the upper receiving valve is opened by atmospheric pressure, and air enters the upper end of the air cylinder filling all space in the air cylinder behind the downward moving piston.

Q. What are the duties of the nine and one-half inch pump?

A. They are the same as those of the eight inch pump and are performed in nearly the same manner.

NINE AND ONE-HALF INCH AIR PUMP.

60 Top head.
61 Steam cylinder.
62 Center piece 1 forms lower steam head and upper air head.
63 Air cylinder.
64 Lower head.
65 Steam piston and rod.
66 Air piston.
67 Piston packing ring.
68 Piston rod nut.
69 Reversing valve plate.
70 Reversing valve plate bolt.
71 Reversing valve rod.
72 Reversing valve.
73 Reversing valve chamber bush.
74 Reversing valve chamber cap.
75 Main valve bush.
76 Main piston valve.
77 Large main valve piston head.
78 Large main valve piston packing ring.
79 Small main valve piston head.
80 Small main valve piston packing ring.
81 Main valve stem.
82 Main valve stem nut.
83 Main slide valve.
84 Right main valve cylinder head.
85 Left main valve cylinder head.
86 Air valve.
87 Air valve seat.
88 Air valve cage.
89 Air valve chamber cap.
90 One and one-fourth inch union stud.
91 One and one-fourth inch union nut.
92 One and one-fourth inch union swivel.
93 One inch steam pipe stud.
94 Governor union nut.
95 Stuffing box.
96 Stuffing box nut.
97 Stuffing box gland.
98 Air cylinder oil cup.
99 Short cap screw.
100 Long cap screw.
101 Upper steam cylinder gasket.
102 Lower steam cylinder gasket.
103 Upper air cylinder gasket.
104 Lower air cylinder gasket.
105 Drain cock.
106 Air strainer.
107 One-inch steam pipe sleeve.
108 Left main valve head gasket.
109 Right main valve head gasket.
110 Main valve head bolt.
111 Cap screw.
112 Cylinder head plug.

Q. What is the principal difference in construction between the eight inch and the nine and one-half inch pump?

A. The principal difference in construction of the two pumps lies in the reversing valve gear.

Q. Has the nine and one-half inch pump a main valve the same as the eight inch pump?

A. It has a main valve, of the slide valve pattern, operated by a differential piston. The slide valve is held between the heads of the differential pistons, 77 and 79. The main valve of the eight-inch is a combined differential piston and reversing valve.

Q. Where does the steam first enter the nine and one-half inch pump?

A. At the side as indicated on Figure 5 the same as in the eight-inch pump, except that in the nine and one-half inch pump the steam must pass up through a suitably arranged passage in the wall of the steam cylinder to the top head before it can enter the steam chamber where it is admitted between the ends of the differential piston, the same as between the ends of the main steam valve in the eight-inch pump.

Q. How does steam pass from the steam chamber in the top head to the cylinder of the pump?

A. The two pistons comprising the differential piston being of unequal area the total pressure of the larger piston is greater than that on the smaller piston, and consequently the whole

WESTINGHOUSE NINE AND ONE-HALF INCH PUMP.

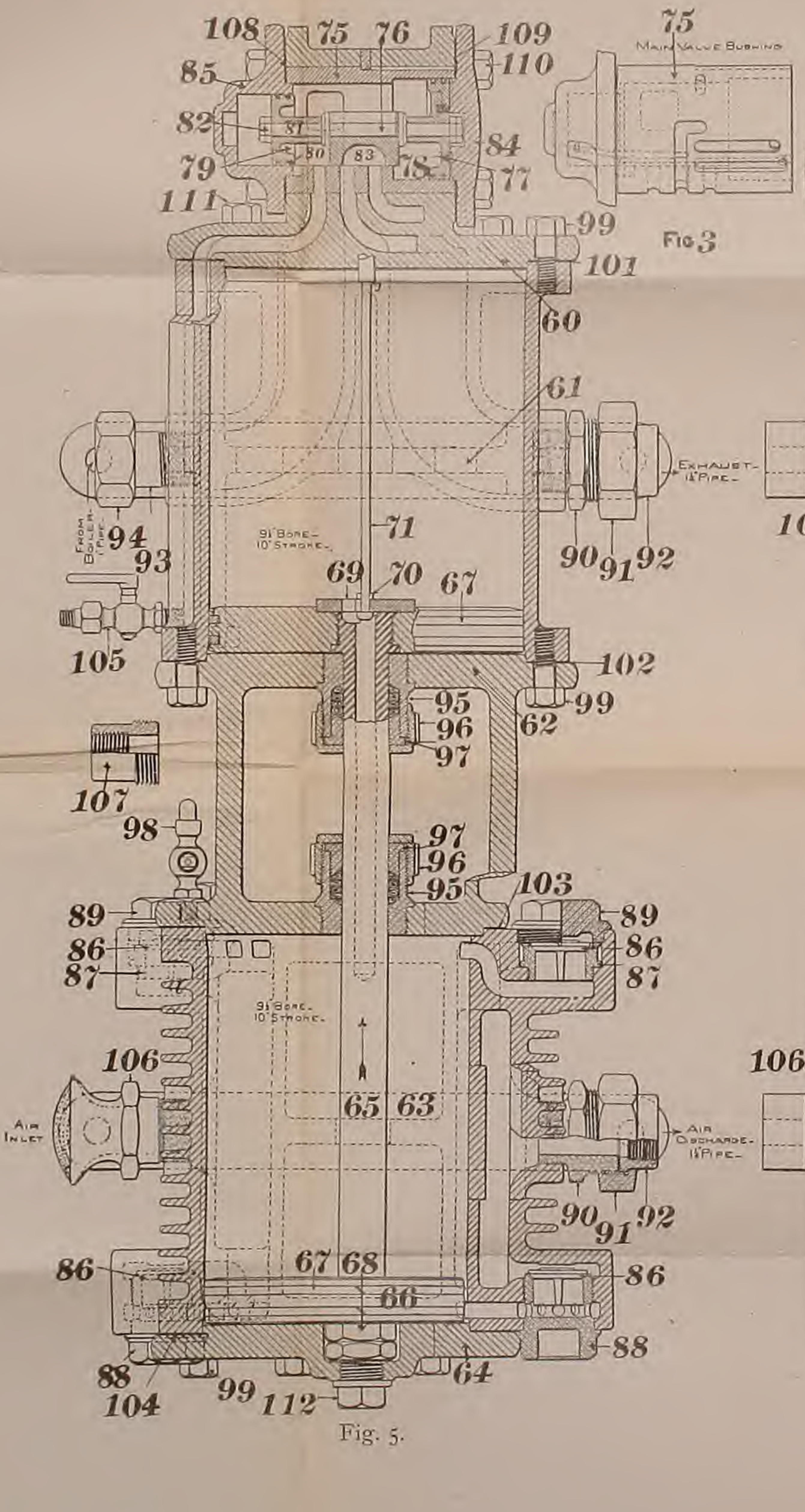


Fig. 5.

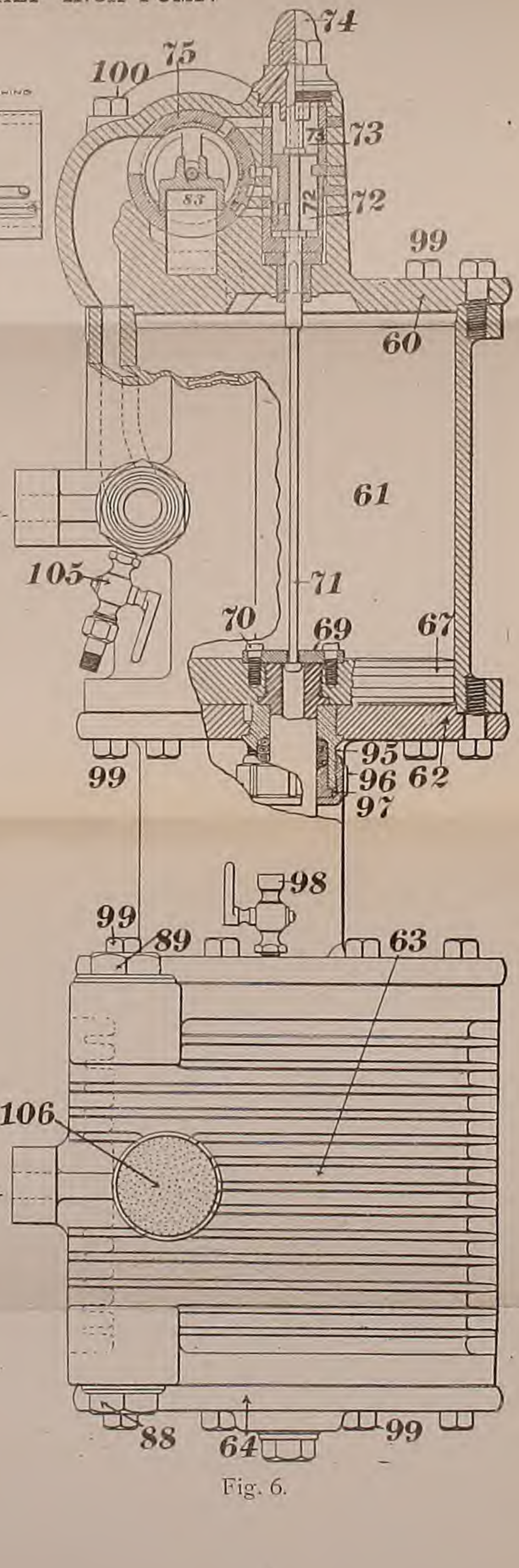


Fig. 6.

differential piston together with the main slide valve, which is caught between the ends, moves to the right, and in so doing the main slide valve uncovers the steam port on the seat which leads to the lower end of the cylinder and at the same time, connects the steam port leading to the top of the cylinder with the exhaust passage to the atmosphere. Mr. Dickson adds: "through a cavity in centre of the main slide valve."

Q. When the upward stroke is completed how is the motion reversed?

A. As the main steam piston 65 approaches the upper end of its stroke, the reversing plate 70 engages the reversing valve rod 71 and carries it together with the reversing slide valve up to the end of the latter's travel. The reversing slide valve when in its extreme upper position, opens a steam port leading to the outer face of the large differential piston 77. The pressure admitted to the outer face of this piston combined with the pressure acting upon the inside face of the smaller piston moves the differential piston and along with it, the main slide valve 76 in the opposite direction or to the left, and in doing so the steam port leading to the upper end of the steam cylinder is uncovered so as to admit steam to this end, while the lower steam port is connected with the exhaust passage leading to the atmosphere, through main slide valve cavity.

Q. When the downward stroke is made how is the action of the piston reversed?

A. When the main piston approaches close to the lower end of its stroke, the reversing valve plate engages the button head, formed on the lower end of the reversing valve rod, and moves it, together with the reversing slide valve, downward until the latter (Mr. Dickson says:) "covers steam port leading to outer face of differential piston and opens a port from same to the atmosphere." The steam acting on the inside face moves differential piston and main slide valve to the right which uncovers the steam port leading to the lower end of the steam cylinder, and at the same time connects the steam port to the upper end of the cylinder with the atmosphere.

Q. How is the reversing slide valve supplied with steam?

A. It is supplied through a suitable port, located between the ends of the differential piston, which leads to the reversing slide valve chamber.

Q. Describe the operation of the air end of the pump?

A. It is the same as that of the eight-inch pump. When the air piston is descending in the air cylinder, the air underneath it is being compressed and driven out through the lower discharge valve to the main reservoir, while at the same time the upper receiving valve is open, and air from the atmosphere is entering the air cylinder filling the space behind the piston. On the upward stroke, as the air piston is ascending, the

NEW YORK DUPLEX PUMP.

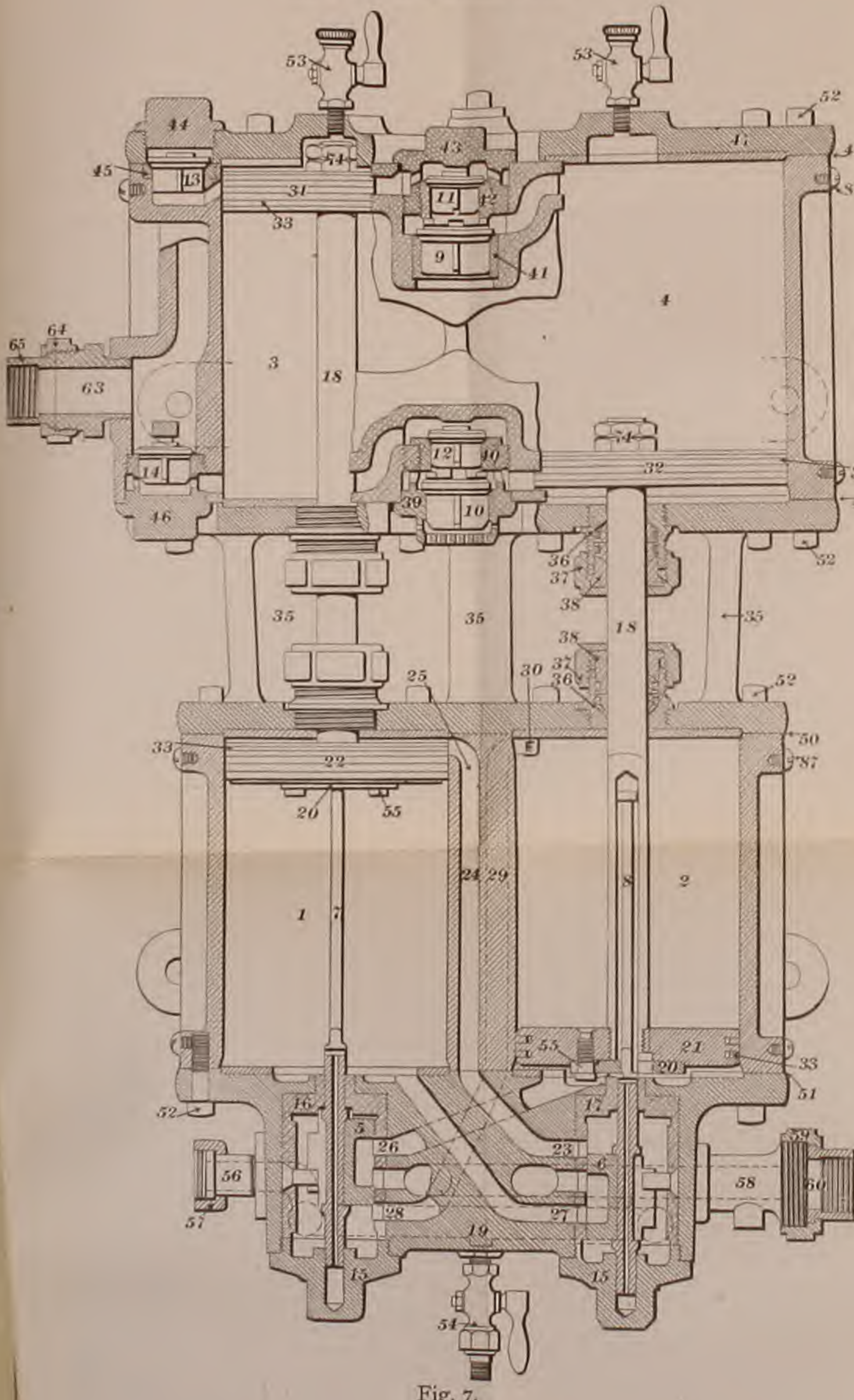


Fig. 7.

air in front of it is compressed and driven out through the upper discharge valve, while at the same time the lower receiving valve is open and air is entering the cylinder filling the space behind the air piston. In the operation of all air compressors the air pistons are double acting.

Q. What is meant by double acting air pumps?

A. It is meant that they have two sets of air valves—two receiving and two discharge valves—and that at each stroke of the air piston air is both taken into and discharged from the cylinder.

Q. How many cylinders has the New York Duplex pump?

A. It has two combined steam and two combined air cylinders, making four in all.

Q. How do the cylinders compare in size?

A. Both steam cylinders and one air cylinder are the same in diameter, and the other air cylinder is of such a diameter as to give double the cubical capacity of any one of the other cylinders.

Q. How is steam admitted to the steam cylinder?

A. Steam is admitted to the steam cylinders through ports controlled by ordinary D slide valves.

Q. How many slide valves and reversing valve rods are required?

A. Two of each. One slide valve and one tappet rod for each cylinder. Mr. Dickson says

DUPLEX AIR PUMP.

1-2 Steam cylinders.
3-4 Air cylinders.
5-6 Slide valves.
7-8 Valve stems.
9-10 Receiving air valves.
11-12 Intermediate receiving and discharge air valves.
13-14 Discharging air valves.
15 Steam chest caps.
16-17 Steam chest bushings.
18 Piston rods.
19 Upper steam head.
20 Tappet plates.
21-22 Steam pistons.
32 Low pressure air piston.
33 High pressure air piston rings.
34 Low pressure air piston rings.
35 Center piece (forms upper steam cylinder head and lower air cylinder heads).
36 Stuffing boxes.
37 Stuffing box nuts.
38 Stuffing box glands.
39 Lower receiving valve chamber.
40 Lower intermediate valve seat.
41 Upper receiving valve seat.
42 Upper intermediate valve seat.
43 Upper intermediate valve chamber.
44 Upper discharging valve cap.
45 Upper discharging valve seat.
46 Lower discharging valve seat.
47 Top air cylinder head.
48 Upper air cylinder gasket.
49 Lower air cylinder gasket.
50 Upper steam cylinder gasket.
51 Lower steam cylinder gasket.
52 Cylinder head bolts.
53 Air cylinder oil cups.
54 Drain cock.
55 Tappet plate bolt.
56 Governor union stud.
57 Governor union nut.
58 Exhaust union stud.
59 Exhaust union nut.
60 Exhaust union swivel.
63 Air union stud.
64 Air union nut.
65 Air union swivel.
74 Piston rod nut.
87 Jacket screws.

they should be called tappet rods instead of reversing valve rods.

Q. How are reversing slide valves operated?

A. They are moved by means of the tappet rods, and tappet plates and the main pistons.

Q. Does each steam piston operate the slide valve that controls the admission to and the exhaust of steam from its own cylinder?

A. No; each steam piston moves the slide valve that controls the steam distribution in the other steam cylinder.

Q. How is it that the slide valve under one steam cylinder can control the admission and the exhaust of steam to and from the other steam cylinder?

A. It is because the steam ports are crossed—that is, the steam ports controlled by one of the slide valves cross over and lead to the other cylinder.

Q. Describe the reversing slide valves and their seats.

A. They are ordinary D slide valves, very much like those used in locomotives, and in their seats there are three ports, two steam and one—the middle one—an exhaust port.

Q. What moves the reversing slide valves?

A. The tappet rods which are fitted into holes drilled into the steam ends of the piston rod, and in turn these rods are moved by tappet rod plates bolted to the piston head.

Q. How are the steam ports arranged in the steam chest of the duplex pump?

A. The upper port in the left chest leads to the lower end of the right steam cylinder, and the upper port of the right steam chest leads to the upper end of the left steam cylinder. The lower port in the right steam chest leads to the lower end of the left steam cylinder and the lower left steam port leads to the upper end of the right steam cylinder.

Q. Do both pistons of the duplex pump move in the same or opposite directions at the same time?

A. Both pistons of the duplex pump do not move in any direction at the same time. But one piston moves at a time, and after it has completed its stroke it waits until the other piston makes a stroke before commencing its return stroke.

Q. In starting the pump, which piston makes the first stroke?

A. The right hand piston, or the one below the larger air cylinder, commonly called the low-pressure piston.

Q. How do the pistons move, upon starting the pump?

A. Both pistons and both slide valves being at their lower extremities, upon turning on steam to the pump, the right hand piston moves to the upper end of its stroke, moving its slide valve to the upper extremity of its travel, just before reaching the end of its stroke; it then waits until the other piston makes its upstroke and changes its slide valve, so as to admit steam to the upper end of the right piston and to exhaust steam from the lower side of the right piston, thus providing for the latter's down stroke. As it approaches the end of its down stroke, it again moves its slide valve in the downward direction, and so provides for the down stroke of the left piston.

Q. How many air valves has the New York duplex pump?

A. Six.

Q. What are they called?

A. Two are called the air inlet valves; two, the intermediate airlet and discharge valves; and two, the final discharge valves.

Q. How is air taken into the air end of the pump, compressed and discharged to the main reservoir?

A. The large or low pressure piston moves up first, creating a vacuum in its cylinder behind it, which is filled with air from the atmosphere, drawn into the cylinder through the lower air inlet valve 10; when the small or high pressure air piston moves up, creating a vacuum in its cylinder behind it, which is filled with air from the atmosphere, drawn into the air cylinder through the lower air-inlet and the lower intermediate air-inlet and discharge valves 10 and 12. After the high pressure piston has completed its up-stroke, both air cylinders are filled with free air at atmospheric pressure, and the low-pressure piston commences to move downward and to compress the air in front of it previously received on the up stroke, and to discharge it into the high pressure air cylinder through the lower intermediate air-let and discharge valve 12. After the low pressure piston has completed its down stroke and has forced the contents of the large air cylinder into the small air cylinder, the high pressure air piston makes its down stroke and forces all the air in the high pressure air cylinder in front of it into the main reservoir through the lower final discharge valve 14. On the down stroke of both pistons air from the atmosphere is taken into the air cylinders in precisely the same manner as that explained for the up stroke and the operation of compression and final discharge of air to the main reservoir is the same for the up stroke as for the down stroke.

Q. At about what pressure does the low pressure piston work against?

A. About forty pounds, after the pressure has been accumulated in the main reservoir.

Q. How much pressure does the high pressure piston work against?

A. A trifle higher than main reservoir pressure, which is generally ninety pounds.

AIR PUMPS IN GENERAL.

Q. How should an air pump be started?

A. The air pump, no matter of what make, should be started slowly at first and should not be speeded up until a pressure of forty pounds has accumulated in the main reservoir.

Q. Why should an air pump be run slowly until considerable pressure has accumulated in the main reservoir?

A. Because all air compressors, used to furnish air pressure for the automatic air brake, depend, to a considerable extent, upon the pressure in the main reservoir for a cushion for the air pistons, so as to prevent them from striking the cylinder head.

Q. How fast should an air pump be run?

A. Just fast enough to keep up the required train-pipe pressure and no faster.

Q. What will be the result if the rod packing blows out?

A. It will blow the oil from the swab on the piston rods and if the blow comes from the air end of the pump it will greatly reduce its efficiency.

Q. What are the most common causes of knocks or pounds in air pumps?

A. The lack of air cushions to stop the pistons at the completion of their stroke, loose nuts on the ends of the air pistons, leaky air valves or loose pistons, due to pounding on cylinder heads. Mr. Gesner adds: "Too much lift in discharge valves or pump being loose on its brackets." Mr. Dickson gives the following answer to the above question: "On Westinghouse pumps, wear of reversing plate or between shoulders of reversing rod, stuck air valves or air valves with too much lift, loose nuts on pistons. On the New York pump, loss of cushion by leaky oil cups, receiving valves, packing rings of air pistons, piston rod packing of air end or cylinder head gaskets. On either kind of pump, loose on brackets or running fast against too low a pressure."

Q. What should be done at about the same time that the steam throttle to the air pump is opened?

A. The lubricator should be started and it should be allowed to feed freely at first, and afterward, when the pump is free from all water or condensation and thoroughly warmed up, the feed should be adjusted to meet the work the pump has to do.

Q. When should the air cylinders of air pumps be oiled?

A. The air cylinder of any air pump, required to do heavy duty, should receive a small quantity of good oil that will stand a high degree of heat, before it is started, and should be oiled as often during the trip as circumstances and the work it is doing indicate it should be oiled. The air cylinders of air pumps require oil more often nowadays than they did formerly when air brake trains were shorter.

Q. What kind of oil is good for the air cylinders?

A. Valve oil gives best results.

Q. How should oil be introduced to the air cylinders?

A. Through the oil cups provided for that purpose.

Q. Should oil ever be introduced through the air-inlet valve?

A. No; oil, if introduced through the air-inlet valve, will gum up the air valves and air passages, and thus tend to make the pump run hot.

Q. How tight should the piston rods be packed?

A. Just tight enough to prevent leakage of steam or of air.

Q. How should the air pump be run while descending grades?

A. With the pump throttle well open, and fast enough to provide an ample supply of air.

Q. While ascending grades or going over level road, how should the air pump be run?

A. Fast enough to maintain the required pressure in the train pipe and auxiliaries—that is, fast enough to do the work required.

Q. With the New York pump, if the exhausts are not spaced properly, what could be the trouble?

A. Leakage of air from the main reservoir back into the high pressure air cylinder, unequal lift of air valve, back leakage between high and low pressure cylinders, or some one of the air valves stuck open or held fast to its seat.

Q. If an intermediate valve or a cylinder head gasket is leaking between the air cylinders, how could it be detected?

A. Two of the steam exhausts will sound well apart, and two will sound close together.

Q. How is it that leaks of the above description cause the exhausts to sound irregular?

A. Because air leaking from the high pressure cylinder back into the low pressure cylinder creates an air pressure in the latter that tends to force the low pressure piston in the same direction that the steam pressure is, and therefore, it makes a very quick stroke.

Q. When three strokes of the duplex pump are irregular, but the fourth is made very slowly, what is the trouble?

A. An intermediate discharge valve possibly may be broken, but the trouble is more likely to be air cylinder gasket leaking between the final discharge valve cavity and the high pressure cylinder, or the lower intermediate valve seat is loose, and has unscrewed, raising the intermediate valve against its stop post.

Q. What will be the effect if the upper intermediate valve seat works loose?

A. The upper intermediate valve seat forms the lift stop for the upper receiving valve, and if it gets loose it will work down and prevent the opening of the receiving valve.

Q. Which air cylinder of the duplex pump requires more oil than the other?

A. The high-pressure air cylinder will require more oil than the low pressure, owing to the compression in the cylinder being higher.

Q. What should be done when an air pump stops of its own accord?

A. About the first place to look is at the small escape port in the neck of the governor or in the top of governor piston cylinder. If there is a constant flow of pressure at this small hole (Mr. Gesner says:) "while the brakes are applied with the New York and releasing with the Westinghouse equipment," it indicates that the diaphragm valve, or pin valve, as the case may be, is leaking. If there is not a flow of air at this port, push a pin into it and make sure it is not blocked up, after which, if the pump does not start, close the pump throttle, open the waste cock to the steam head of pump, allowing all pressure to escape, then close the waste cock and open the throttle quickly.

Q. If, after the throttle test is made, the low pressure piston moves up to and stops at the upper end of its stroke, and the high pressure piston refuses to move, where should one look for the trouble?

A. In the steam head of the pump under the low pressure piston. Either the low pressure tappet rod is broken or its reversing valve plate is worn through.

Q. After the throttle test, suppose the low pressure piston makes the up stroke, then the high pressure piston makes its up stroke, but the low pressure piston refuses to make its down stroke, where would the trouble be?

A. In the steam cylinder or head of the high pressure cylinder. Probably the tappet rod is broken or its tappet plate is worn through. Mr. Dickson asks and answers the following question:

Q. What is the cause of the air pump running hot?

A. Air piston packing rings leaking; discharge valves leaking; too small an amount of lift of discharge valve, discharge valves stuck, or discharge pipe or ports plugged; racing the pump, or continual compression against too high main reservoir pressure.

THE ENGINEER'S BRAKE VALVE.

DESCRIPTION OF THE PASSAGE OF AIR THROUGH D 8 VALVE IN DIFFERENT POSITIONS.

Full Release Position.

With the handle of the valve in full release position (Fig. 9) air coming from the main reservoir enters the brake valve at X passes to

WESTINGHOUSE D-8 ENGINEER'S BRAKE VALVE.

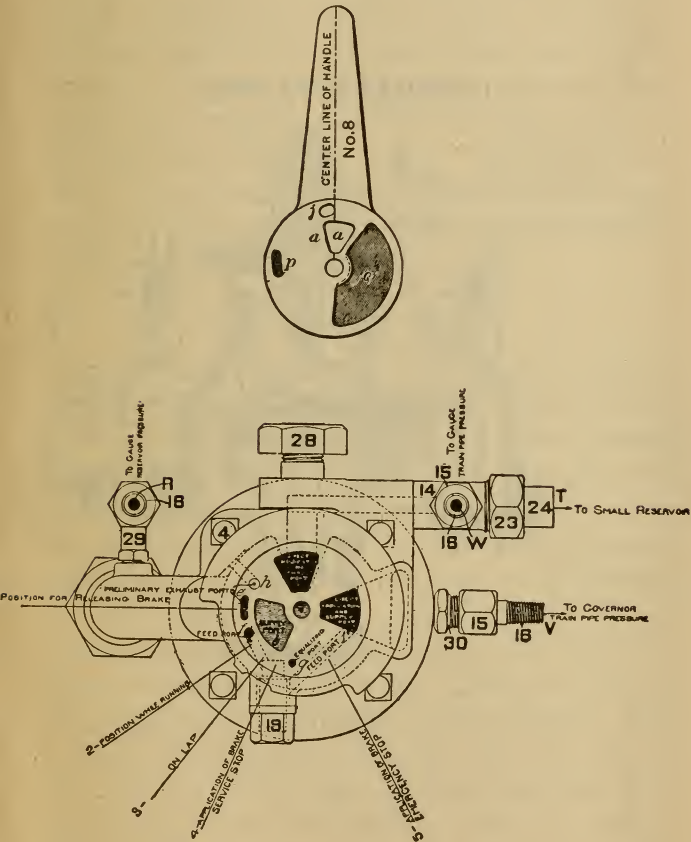


Fig. 8.

D-8 BRAKE VALVE.

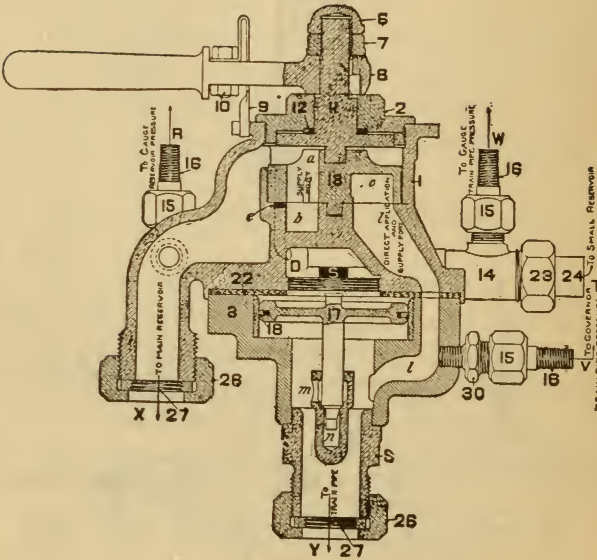


Fig. 9.

top of the rotary, through port *a* of the rotary 13, port *b* of the rotary seat and into cavity *c* of the rotary, thence through port *l* into the train line at Y. Port *g* in the rotary seat (Fig. 8) leads to chamber D and is exposed to cavity *c* of the rotary with the valve in this position so that air passing from the main reservoir into train line through cavity *c* is also free to go to the little drum through port *g*. In this position port *j* in the rotary is open to port *e* in the rotary seat and main reservoir pressure passes directly to the little drum through these ports.

RUNNING POSITION.

In this position port *j* in the rotary is moved around so that it communicates with port *f* in the rotary seat. Main reservoir pressure coming from the top of the rotary feeds through ports *j* and *f* and strikes the excess pressure valve which is held to its seat by the excess pressure spring. This spring has a tension of 20 pounds so that when main reservoir pressure is 20 pounds greater than that back of the valve, or train line pressure, the valve is forced from its seat and main reservoir air passes through port *f* (Fig. 8) into port *l* and into the train line at Y (Fig. 9). While the air feeds into the train line through port *l* it feeds up under the rotary into cavity *c* which is exposed to port *l* as in full release, port *g* in rotary seat (Fig. 8) is still exposed to cavity *c* and the air passing into the train line also passes up into cavity *c* and through port *g* into cavity D or the little drum (Figs. 8 and 9). In lap position all ports are blanked.

In service position the slot *p* on the under side of the rotary connects port *e* which leads through the rotary seat to the little drum with port *h* in the rotary seat leading to the atmosphere.

The emergency position of this valve is the same as the D 5, F 6 or G 6 valves.

Q. What is the engineer's brake valve?

A. It is the valve with which the engineer controls the operation of the brakes on the train.

Q. How many positions are there for the handle of this valve?

A. Five.

Q. What are they called?

A. Full release, running, lap, service and emergency, and commencing with full release position they are arranged in the order named.

Q. Is the old Westinghouse D 8 valve still in use?

A. Yes; quite extensively.

Q. How does this valve compare with the G 6 and other brake valves of the Westinghouse type?

A. Though the valves are constructed differently, the results obtained are the same.

Q. In full release position how many ports lead to little drum?

A. Two; the same as with the F 6 or G 6.

Q. What gives us the excess pressure in the main reservoir?

A. The excess pressure spring which has a tension of 20 pounds.

Q. Is air drawn from cavity D, or little drum in service position?

A. Yes.

Q. How does the reduction of little drum pressure affect the equalizing piston 17?

A. Same as with F 6 or G 6 valves.

Q. Is there any noticeable difference between the service positions of the Westinghouse and of the New York brake valves?

A. Yes; the service position on the New York brake valve is subdivided into five service-graduating notches, while the service position on the Westinghouse valve is not.

Q. Why is the service position on the New York brake valve subdivided?

A. Because in this position the valve automatically measures the amount of train pipe reduction, and laps itself.

Q. In what position of the brake valve is there a direct opening from the main reservoir to the train pipe?

A. In full release position.

Q. Are the train pipe and the main reservoir pressures equal in this position?

A. They are.

Q. Why are they equal in full release position?

A. Because there is a large, direct communication between the main reservoir and the train pipe through the brake valve, when the handle is in this position.

Q. When the handle is in the running position, how does the air pass from the main reservoir into the train pipe?

A. In the Westinghouse brake valve D 5, F 6 and G 6 it passes through the feed valve attachment, and in the New York brake valve it passes through the excess pressure valve, into the train pipe.

Q. With the D 8 valve how does air pass from main reservoir into train pipe?

A. Through the excess pressure valve.

Q. What are the duties of the feed valve attachment?

A. To feed air into the train pipe as fast as it may be needed to keep up the pressure therein, and to close the communication between the main reservoir, and the train pipe when the pressure in the latter has reached the limit for which the feed valve is adjusted.

Q. What are the duties of the excess pressure valve?

A. To permit air to feed into the train pipe from the main reservoir, and to maintain an excess pressure in the latter of about twenty pounds.

Q. How does the Westinghouse G 6 brake valve obtain its excess pressure?

A. By means of the pump governor which is adjusted to stop the pump when the desired main reservoir pressure has been obtained, which is usually twenty pounds in excess of what is carried in the train pipe.

Q. When the handle is placed in lap position, how does it govern the air passages and ports in the brake valve?

A. It prevents the passage of air through the brake valve in any direction, and closes all ports.

Q. When is the lap position used?

A. When coupling onto a train that is to be charged with air; when the train has parted or the conductor has opened the conductor's valve, when, with the Westinghouse valve, it is desired to hold the brakes applied after a service application has been made. Mr. Roach adds: "Also when backing a train to permit conductor to make stops."

Q. What is the service stop position used for?

A. The handle of the brake valve is operated in the service stop position when making all ordinary stops.

Q. In order to apply the brakes, what is necessary to do?

A. It is necessary to reduce the train pipe pressure below that contained in the auxiliary reservoir.

Q. In making an ordinary or service appli-

G-6 ENGINEER'S BRAKE VALVE.

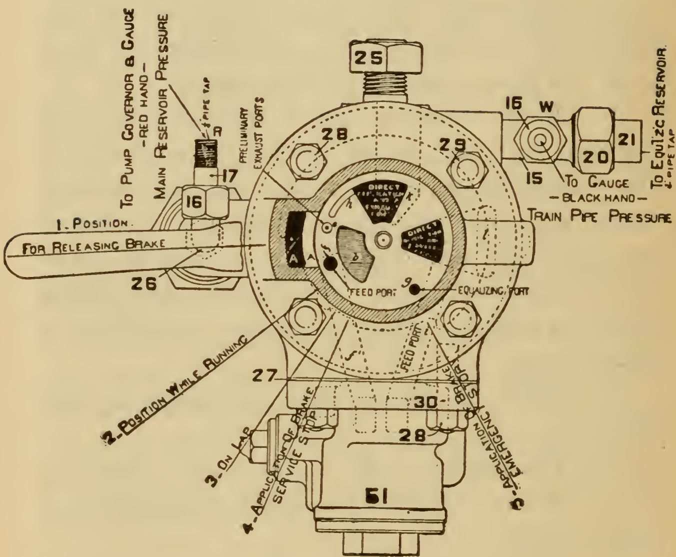


Fig. 10.

G-6 ENGINEER'S BRAKE VALVE.

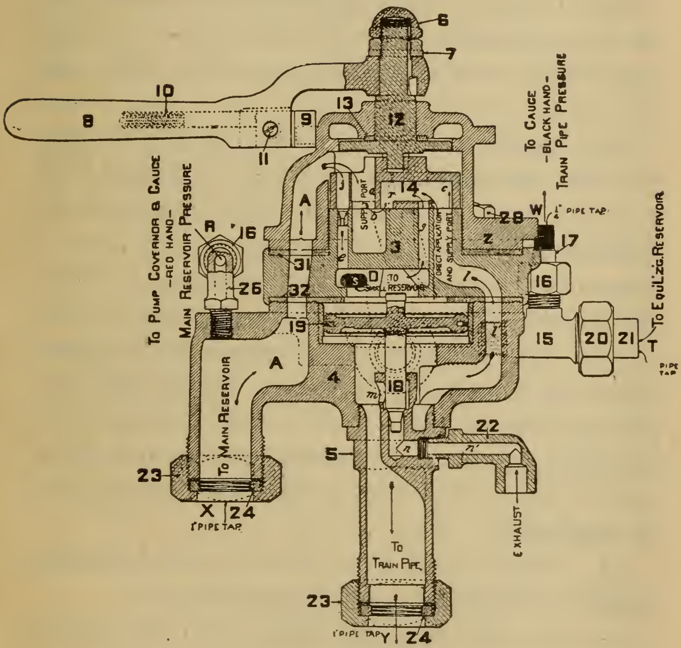


Fig. 11.

cation, does the engineer reduce the pressure directly from the train pipe?

A. With the Westinghouse brake valve, no; he reduces it from the small equalizing reservoir; with the New York brake valve, yes; he takes it out of the train pipe direct.

Q. With the Westinghouse brake valve, how is it that reducing the pressure from the small equalizing reservoir will cause the train pipe pressure to reduce?

A. In either the full release or the running position, the equalizing reservoir is charged with pressure equal to that in the train pipe, and the equalizing discharge piston forms the line of separation between the two pressures. When the handle of the brake valve is placed in the service stop position, the pressure in the equalizing reservoir begins to reduce, leaving the train pipe pressure greater, which on this account will raise the equalizing discharge piston and valve, and so permit train pipe pressure to escape to the atmosphere.

Q. Why is train pipe pressure reduced in this manner in making service applications?

A. In order that all brakes may be applied gently throughout the whole train, and so that on long trains the reduction of train-pipe pressure being closed off gradually, there will be no trouble experienced from the front brakes releasing

Q. Why would the front brakes on long

trains release if the train-pipe exhaust or air be suddenly closed off?

A. The friction of the air in the pipe causes the pressure in the front end to fall much more rapidly than it does in the rear end, of the train pipe, so that if the exhaust were closed off abruptly there would be a surge of air from the rear to the front end of the train which would raise the pressure in the front end sufficiently to release some of the brakes.

Q. If six pounds of pressure be reduced from the equalizing reservoir, how much will be reduced from the train pipe?

A. The same amount, practically, six pounds.

Q. How does the New York brake valve provide for the gradual closing up of the train pipe reduction in service applications?

A. By means of the automatic cut-off valve and cut-in piston.

Q. Where is the pressure stored that operates the automatic cut-off valve?

A. It is stored in the small supplementary reservoir.

Q. When the handle of the New York brake valve is in the running position, how does the pressure compare on either side of the equalizing discharge piston?

A. The train pipe pressure on one side and the supplementary reservoir pressure on the other side are equal.

NEW YORK ENGINEER'S BRAKE VALVE.

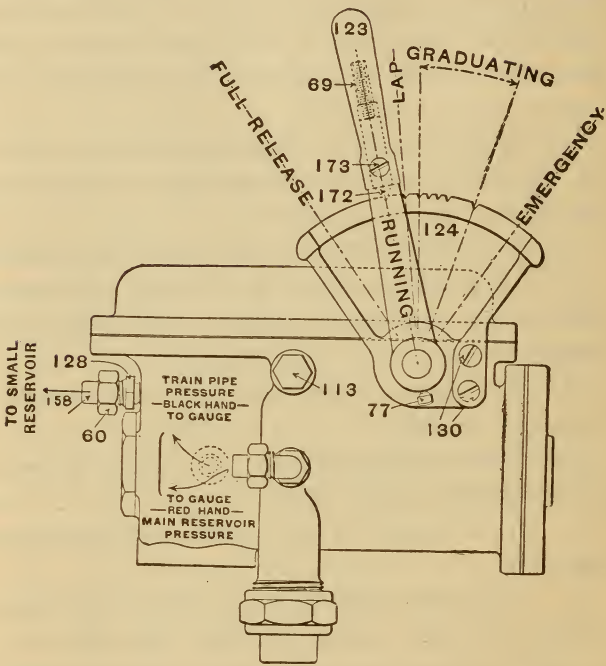


Fig. 12.

NEW YORK ENGINEER'S BRAKE VALVE.

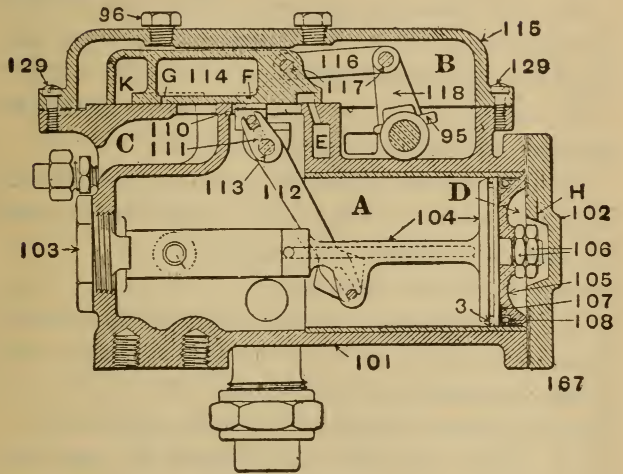


Fig. 13.

NEW YORK ENGINEER'S BRAKE VALVE.

3 Piston ring.
60 Small union nut.
61 Union swivel.
62 Gauge and governor union stud.
69 Handle spring.
77 Handle set screw.
90 Feed valve spring.
95 Lever shaft spring.
96 Oil plugs.
97 Feed valve.
98 Feed valve cap.
101 Valve body.
102 Back cup.
103 End plug.
104 Piston.
105 Follower.
106 Piston nut.
107 Packing leather.
108 Expander.
110 Graduating valve.
111 Graduating valve spring.
112 Graduating valve lever.
113 Fulcrum pin.
114 Main slide valve.
115 Valve cover.
116 Links.
117 Link pins.
118 Slide valve lever.
120 Lever shaft.
121 Lever shaft packing.
123 Handle.
124 Quadrant.
125 One inch union nut.
126 One inch union swivel.
127 One inch union gasket.
128 Small union stud.
129 Cover and head screws.
130 Quadrant screws.
155 Supplementary reservoir.
156 Reservoir plug.
158 Union swivel.
167 Cap gasket.
172 Quadrant latch.
173 Latch pin.

Q. How does the automatic cut-off feature of the New York brake valve operate?

A. As train pipe pressure reduces in front of the piston, supplementary reservoir pressure behind it is stronger and moves the piston together with the cut-off valve until the latter covers the service exhaust port in the main slide valve.

Q. Then the principle of the operation of this automatic cut-off feature must be the same as that of the plain triple valve?

A. It is just the same.

Q. In making a service application, does the blow or exhaust of air from the train pipe vary with the number of air-braked cars in the train for any given number of pounds' reduction?

A. Yes; to make a reduction in train pipe pressure of a specified number of pounds will require a longer time if the train be long than if the train be short. This is on account of the greater volume of air contained in the longer train pipe, and because it had nearly the same sized opening to escape through in both cases.

Q. What is the last position of the brake called?

A. The emergency; it should be used whenever there is danger of accident.

Q. In case there is danger of accident and the handle of the brake valve is placed in the emergency position, should it be allowed to remain there until the train stops?

A. Yes, always; unless the danger is passed before the train stops and the train is short. After an emergency application on a freight train the brakes should never be released until after the train has stopped.

Q. Does the equalizing feature of the brake valve operate in the emergency position?

A. No; in the emergency the port opening through the brake valve to the atmosphere is large and direct.

Q. What is the operative difference between the feed valve attachment on the Westinghouse brake valve and the excess pressure valve in the New York brake valve?

A. With the feed valve attachment there is always communication between the main reservoir and the train pipe with the handle of the valve in the running position, until standard train pipe pressure is obtained; with the excess pressure valve when the handle is in running position the communication between the main reservoir and the train pipe is closed until the main reservoir pressure is twenty pounds greater than it is in the train pipe.

Q. Do the feed-valve attachment and excess-pressure valves operate in the full release position?

A. No; in this position the opening through the brake valve for the passage of air from the main reservoir into the train pipe is large and direct.

Q. Why is the opening between the main

reservoir and the train pipe made large when the handle is in the full release position?

A. So that the main reservoir pressure can flow into the train pipe in large volume, and thus insure the prompt release of all brakes.

Q. Why is the warning port necessary in the Westinghouse brake valve?

A. Because, if the handle of the Westinghouse brake valve is left in the full release position for any length of time it will charge the train pipe above standard pressure.

Q. What is likely to happen if the train pipe pressure be allowed to get too high?

A. In emergency applications there would be danger of sliding the wheels.

Q. Of what form is the principal valve in the New York engineer's brake valve?

A. It is the slide-valve form.

Q. What is the form of the principal valve in the Westinghouse brake valve?

A. It is a rotary valve.

Q. Where is the main-reservoir pressure usually found in the engineer's brake valve?

A. On top of the principal valve, that is, the main slide valve and the rotary valve.

Q. Where is the train pipe pressure found in the New York brake valve?

A. Underneath the main slide valve in front of the equalizing discharge piston and in the train pipe air gauge air pipe.

FACE OF SLIDE VALVE.

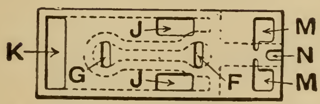


Fig. 14.

SLIDE VALVE SEAT.

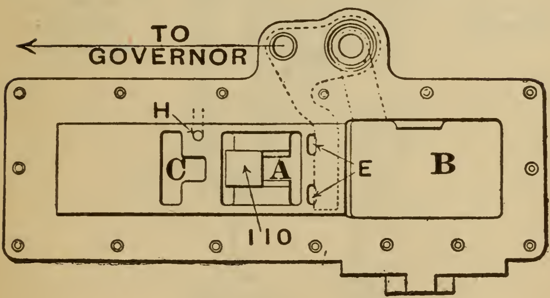


Fig. 15.

NEW YORK ENGINEER'S BRAKE VALVE.

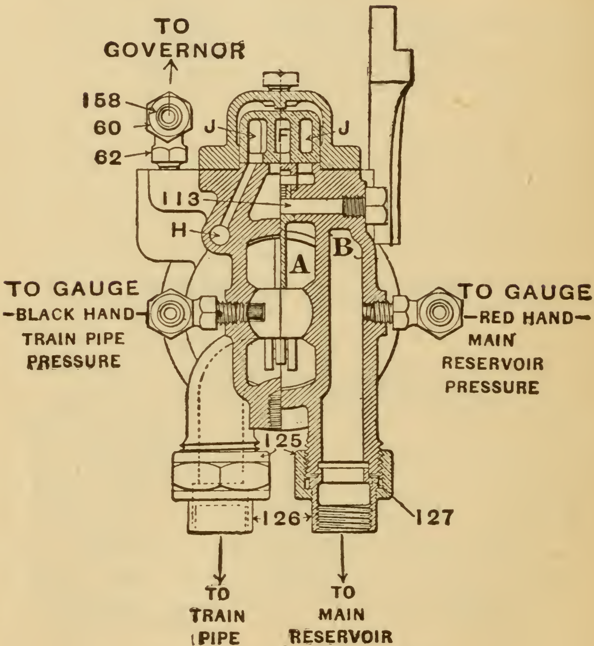


Fig. 16. End Section.

ENGINEER'S BRAKE VALVE.

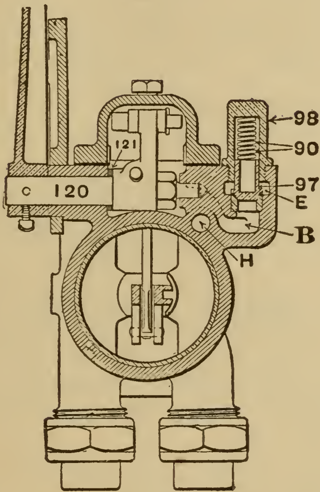


Fig. 17. End Section.

Q. Is not train pipe pressure also present in the governor pipe?

A. Yes; regardless of the position of the brake valve handle; and it always operates the pump governor.

Mr. Dickson says: "Yes in full pressure and in running position, but when the train pipe pressure is reduced to apply brakes governor pipe pressure does not reduce with it."

Q. Where is the supplementary reservoir pressure found in the New York brake valve?

A. It is found immediately behind the equalizing piston and in the supplementary reservoir.

Q. With the New York brake valve what occurs when the handle is placed in full release position?

A. In addition to admitting main-reservoir pressure to the train pipe for the purpose of releasing the brakes, it permits the air in the supplementary reservoir to escape to the atmosphere.

Q. Why is it necessary to discharge the air from the supplementary reservoir when releasing brakes?

A. So that the equalizing discharge piston may return to its normal position, where it should be when a service application of the brake is begun.

Q. In what position must the handle of the brake valve be, in order to charge up the supplementary reservoir?

A. In the running position.

Q. If all the service graduating notches are used how much will the train pipe pressure reduce?

A. About twenty-three pounds when the initial train pipe pressure is greater or less than seventy pounds, then the amount reduced after using all the service notches, will be greater for the greater pressure and less for the lesser pressure.

Q. What is the slide valve feed valve attachment?

A. It is an attachment used in connection with the Westinghouse brake valve.

Q. What are its duties?

A. When the handle of the brake valve is in the running position it automatically supplies the leakage in the train pipe and also acts as a governor limiting the pressure carried in the train pipe.

Q. How is the slide valve feed valve adjusted to regulate the amount of pressure carried in the train pipe.

A. By means of the heavy spring and nut, compressing the spring when it is desired to increase the pressure to be carried by screwing up the nut behind it.

Q. With the New York valve how is the amount of excess pressure carried, regulated with the excess pressure valve?

G-6 ENGINEER'S BRAKE VALVE.

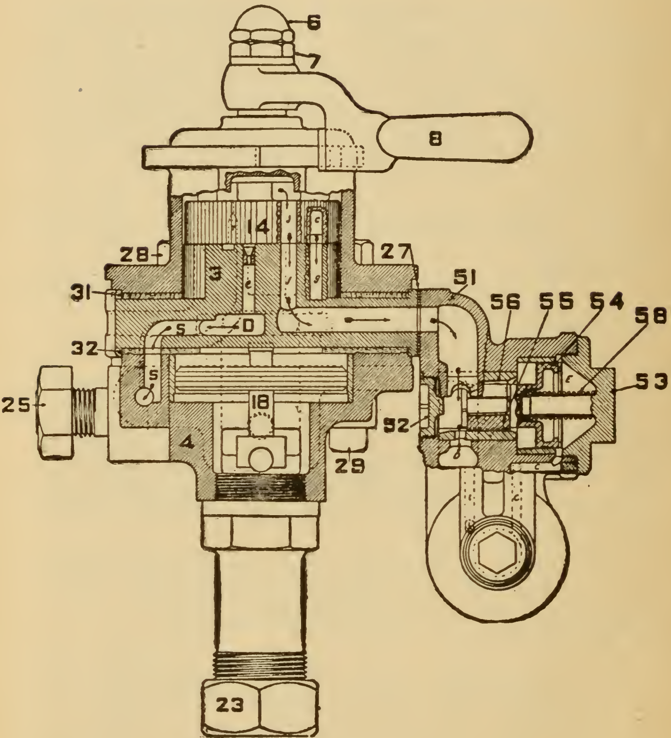


Fig. 18.

ENGINEER'S BRAKE VALVE.

2 Valve body.
3 Rotary-valve seat.
4 Bottom case.
5 Bottom cap.
6 Jam nut.
7 Top nut.
8 Handle.
9 Handle bolt.
10 Handle bolt spring.
11 Handle bolt screw.
12 Rotary-valve key.
13 Washer.
14 Rotary valve.
15 Gauge-pipe tee.
16 One-fourth inch union nut.
17 One-fourth inch union swivel.
18 Piston valve.
19 Piston ring.
20 Three-eighths inch union nut.
21 Three-eighths inch union swivel.
22 Exhaust-pipe fitting.
23 One inch union-nut.
24 One inch union swivel.
25 Holding nut.
26 Gauge-pipe fitting.
27 Feed-valve-case gasket.
28 Half-inch nut.
29 Half-inch bolt.
30 Feed-valve stud.
31 Upper gasket.
32 Lower gasket.
51 Feed-valve body.
52 Flush nut.
53 Cap nut.
54 Supply valve piston.
55 Supply valve.
56 Supply valve spring.
57 Diaphragm.
58 Supply valve piston spring.
59 Regulating valve.
60 Regulating valve spring.
61 Regulating valve cap nut.
62 Spring box.
63 Diaphragm ring.
64 Diaphragm spindle.
65 Regulating nut.
66 Check nut.
67 Regulating spring.

A. By increasing the tension of the excess pressure valve spring.

Q. How is the tension of the spring increased?

A. By placing washers in the cap nut above it. Generally, however, a spring having sufficient tension to maintain the desired excess pressure is used, and when this shows signs of weakening a new spring is substituted.

Q. A leak in the equalizing reservoir or any of its connections, with the Westinghouse brake valve, will produce what effect?

A. It will cause the train pipe exhaust to remain open after the handle of the brake valve has been returned to lap, in all service applications, and will cause the brakes to apply with full force.

Q. What would be the effect of a leak in the supplementary reservoir or any of its connections on the New York brake valve?

A. It would cause a failure of the valve to close off train pipe exhaust automatically in all service applications.

Q. Should the rotary valve leak badly what would be the effect?

A. When the rotary valve leaks main reservoir pressure is feeding into the train pipe at all times regardless of the position of the handle, and this will cause the brakes if applied to release while the handle is on lap; or while the handle is in the running position it will prevent the accumulation of excess pressure in the main reservoir.

Q. If the main slide valve in the New York engineer's brake valve should leak what would be the effect?

A. A leak through the main slide valve generally results in preventing the brake valve from maintaining excess pressure in the main reservoir while the handle is in the running position, and when the service application is being made it generally prevents the cut off valve from entirely closing the service exhaust port in the face of the main slide valve.

Q. How should the feed valves and excess pressure valves be cleaned of dirt and gum?

A. These valves should first be warmed up in order to soften the gum, and then should be wiped clean with a cloth or some waste saturated with kerosene. When replacing use a little light oil to lubricate the slide valve and piston of the slide valve feed valve. No oil is ever required on the excess pressure valve; it should be replaced clean and dry. Mr. Dickson asks and answers the following question:

Q. What is the cause of a continuous blow from exhaust port of the New York brake valve while the handle is in full release position?

A. Usually a leak from train pipe into supplementary reservoir caused by equalizing piston not making a tight joint against cylinder head gasket.

OLD-STYLE FEED VALVE.

Q. What is the feed valve used for?

A. To maintain a predetermined train pipe pressure while the brake valve handle is in running position.

Q. Is it known by any other name?

A. Yes, it is frequently called the train line governor.

Q. What brake valves is this style of feed valve used with?

A. The D 5, E 6 and F 6 brake valves.

Q. Where is the feed valve located?

A. It is attached to the engineer's brake valve.

Q. What parts are thereby placed in communication?

A. When attached to the brake valve, passage f^1 (Fig. 20) registers with passage *f* of the brake valve (Fig. 19) and passage *i* registers with passage *i* of the brake valve, which passage is connected with the train pipe.

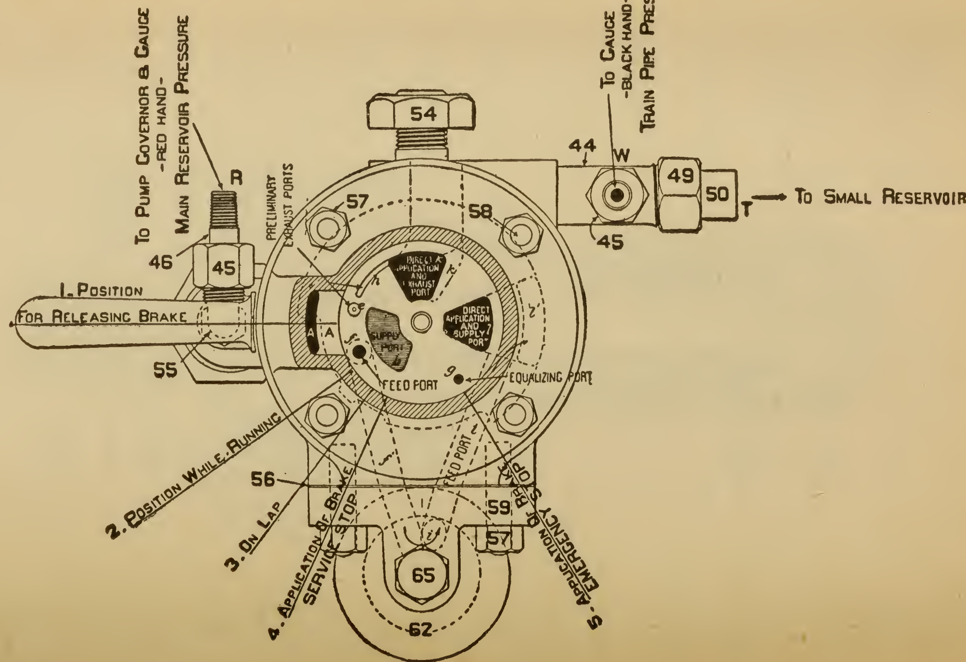
Q. Does the feed valve operate when the handle of the engineer's brake valve is in any other than running position?

A. No.

Q. Explain how it operates when the brake valve handle is in running position.

A. The spring 39 (Fig. 20) supports piston 45 which in turn holds supply valve 34 from its

F 6 BRAKE VALVE.



Feed Valve

Fig. 19.

OLD-STYLE FEED VALVE,

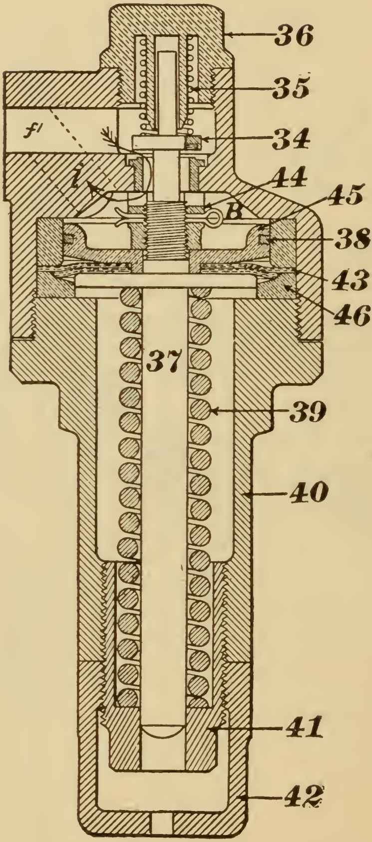


Fig. 20.

seat. So long as the air pressure above piston 45 is less than the tension of spring 39, valve 34 will be held from its seat and main reservoir pressure coming in through port f^1 feeds into port i as indicated by the arrow and on into the train line. When the pressure above the piston overcomes the tension of spring 39 the piston is forced down, permitting supply valve 34 to seat, thereby cutting off main reservoir pressure. When the train line pressure has been reduced, by leakage or otherwise, below seventy pounds the tension of spring 39 will again raise piston 45 and at the same time unseat supply valve 34 permitting main reservoir air to again flow into the train pipe.

Q. Is the train pipe pressure always regulated to seventy pounds?

A. No; on mountainous roads a greater train line pressure is carried.

Q. How can the feed valve be regulated to carry different pressures?

A. By adjusting nut 41 which increases or diminishes the tension of spring 39.

Q. Of what use is the packing ring 38 and the rubber gasket 43?

A. They prevent train line pressure leaking by piston 45 and escaping to the atmosphere.

Q. Full main reservoir pressure sometimes gets into the train pipe. How does it get through the feed valve?

A. There may be dirt or scale on the seat of supply valve 34 or spring 39 may be screwed up too tight, or there may be a leak between the holes of the gasket used between the feed valve and the engineer's valve.

Q. How should valve 34 be cleaned?

A. With oil. The seat should not be scraped to remove any gum as the seat is lead and a scratch would ruin it.

Q. How can this valve be removed when the engine is coupled to a train?

A. By turning the cut out cock in the train pipe beneath the engineer's valve, then place the brake valve handle in service position; to remove the train line pressure between the brake valve and the cut out cock remove cap nut 36 and the valve 34.

Q. What precaution should be taken before replacing valve 34?

A. The brake valve handle should be moved to running position in order to blow out any loose dirt or scale.

Q. Providing piston 45 stuck, how could you remove it?

A. First remove valve 34 as previously explained, then replace the cap nut 36; then remove the lower body 40; hold stem 37 with one hand and with the other hand move the brake valve handle to running position. The main reservoir pressure coming in will blow out the piston, then lap the valve. Do not drive the piston out with a punch unless the punch is at least as large as the stem.

Q. How should the piston be replaced?

A. Very carefully, or you may break something. Enter the packing ring of the piston into the brass bushing, press it upwards, but do not pound it.

Q. Can the feed valve be entirely removed without losing main reservoir pressure?

A. Yes; by placing the engineer's brake valve handle on lap, which blanks all ports.

SLIDE-VALVE FEED VALVE.

Figs. 21 and 22 illustrate the device known as the Slide-Valve Feed Valve, which may be used with either the "D-5," "F-6" or "G-6" Brake Valve, to maintain a predetermined train pipe pressure while the brake-valve handle is in Running Position.

Fig. 21 is a central section through the supply-valve case and governing device, and Fig. 22 is a central section through the regulating valve and spring box and a transverse section through the supply-valve case.

Ports *f* and *i* register with ports in the Brake Valve, designated by similar letters on Fig. 10, and, in Running Position, main-reservoir pressure constantly has free access, through passages *f* and *f*, to chamber F. Chamber E, which is separated from chamber F by supply-valve piston 54, is connected with passage *i*, and thus

SLIDE VALVE FEED VALVE.

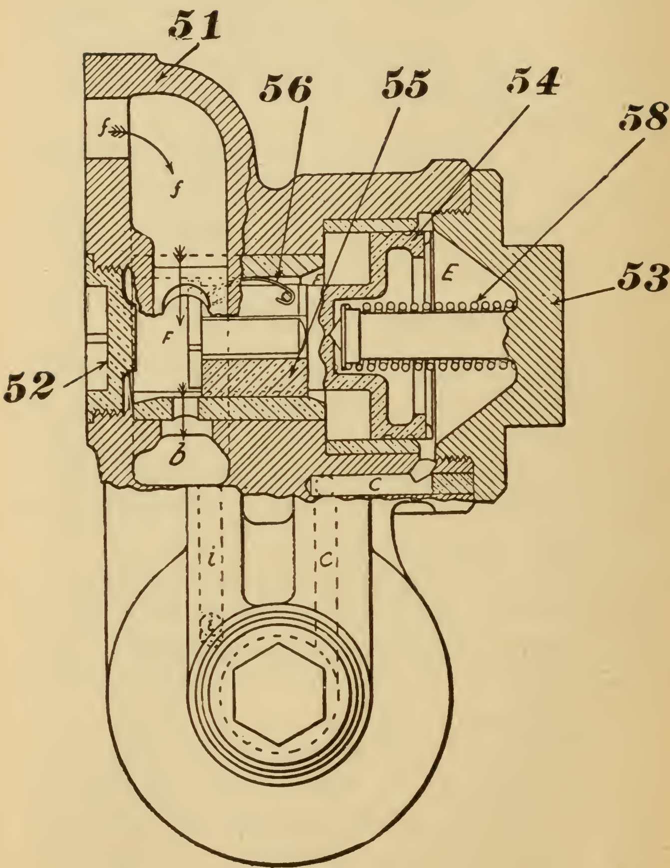


Fig. 21.

SLIDE VALVE FEED VALVE.

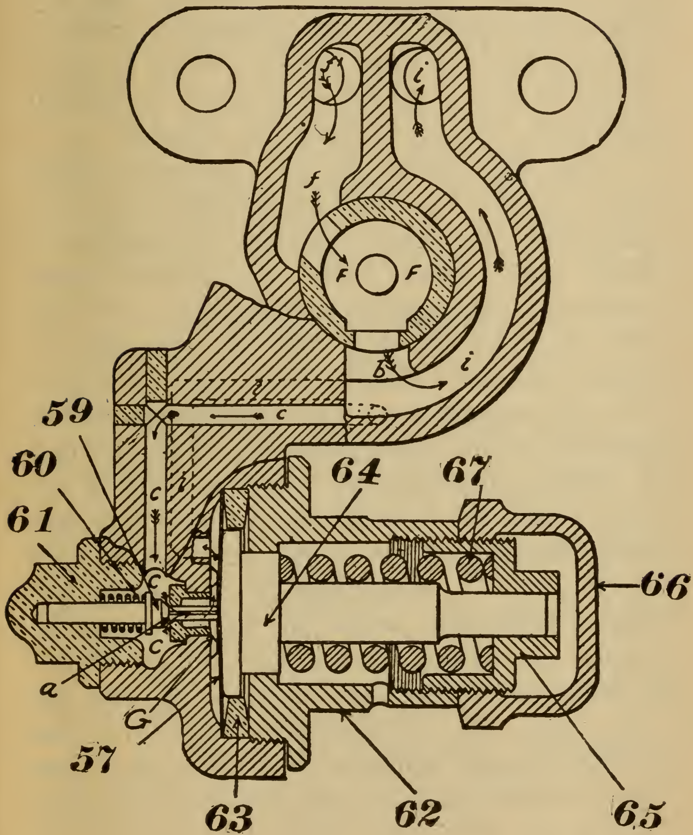


Fig. 22.

with the train pipe, through passage *c, c,* port *a* (controlled by regulating valve 59) and chamber G, under diaphragm 57. Regulating valve 59 is nomally held open by diaphragm 57 and regulating spring 67, the tension of which is adjusted by regulating nut 65. When so open, chamber E is in communication with the train pipe and is subject to train pipe pressure.

When the handle of the Engineer's Brake Valve is placed in Running Position, air pressure from the main reservoir in chamber F forces supply-valve piston 54 forward, compressing its spring 58, carrying supply valve 55 with it and uncovering port *b,* and thereby gains entrance directly into the train pipe through passages *i, i.* The resulting increase of pressure in the train pipe (and so in chamber G under diaphragm 57) continues until it becomes sufficient to overcome the tension of regulating spring 67, previously adjusted to yield at 70 pounds. Diaphragm 57 then yields and allows regulating valve 59 to be seated by spring 60, closing port *a* and cutting off all communication between chamber E and the train pipe. The pressures in chambers F and E then become equalized, through leakage past supply-valve piston 54, and supply-valve-piston spring 58, previously compressed by the relatively high pressure in chamber F, now reacts and forces supply valve 55 to its normal position, closing port *b* and cutting off communication between the main reservoir and the train pipe. A subsequent reduction of train pipe pressure reduces the pressure in chamber G and permits regulating spring 67 to force regulating valve 59 from its seat thereby causing the accumulated pressure in chamber E to discharge into the train pipe. The equilibrium of pressure upon the opposite faces of supply-valve piston 54 being thus destroyed the higher main-reservoir pressure in chamber F again forces it with supply valve 55, forward and recharges the train pipe through port *b*, as before.

PUMP GOVERNORS.

Q. What are the duties of the pump governor?

A. To automatically shut off the steam from the air pump when the desired air-pressure has been accumulated in the main reservoir or train line pipe, stopping it and again admitting steam to the pump to start it when the air pressure falls a trifle below the amount which should be carried.

Q. How does the pump governor shut off the steam from the air pump?

A. By means of a steam valve operated by the governor piston, which is located in the steam passage leading to the pump.

Q. When the proper amount of pressure has been obtained, how does the governor operate to stop the pump?

NEW YORK PUMP GOVERNOR.

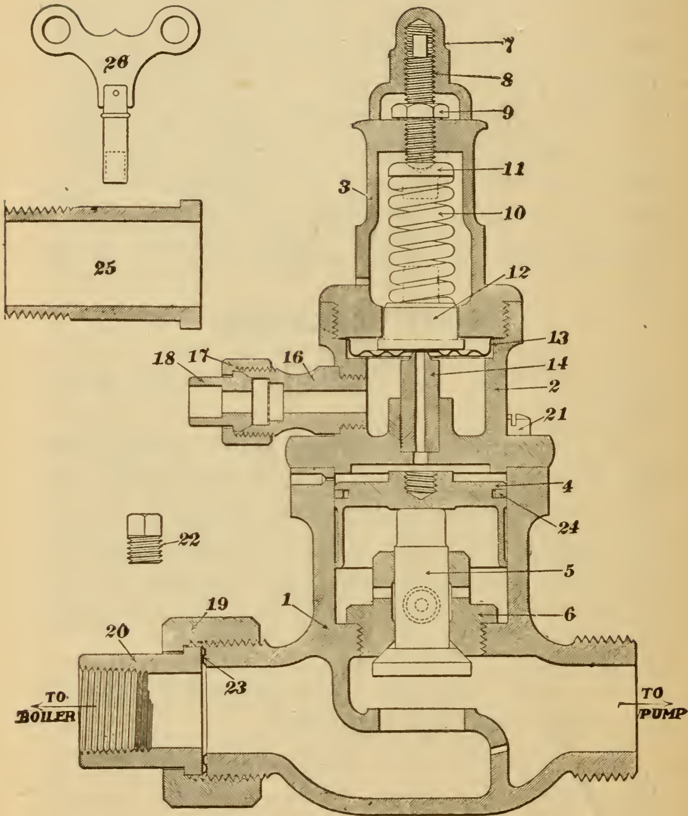


Fig. 23.

PUMP GOVERNOR.

1 Steam valve body.
2 Air valve chamber.
3 Spring casing.
4 Piston.
5 Steam valve.
6 Steam valve guide.
7 Cap.
8 Adjusting screw.
9 Jam nut.
10 Regulating spring.
11 Upper spring washer.
12 Diaphragm button.
13 Diaphragm.
14 Air valve seat.
16 Air union stud.
17 Air union nut.
18 Air union swivel.
19 Steam union nut.
20 Steam union swivel.
21 Screw.
22 Drain plug.
23 Steam union gasket.
24 Piston ring.
25 Steam union swivel.
26 Key.

WESTINGHOUSE ONE-INCH PUMP GOVERNOR.

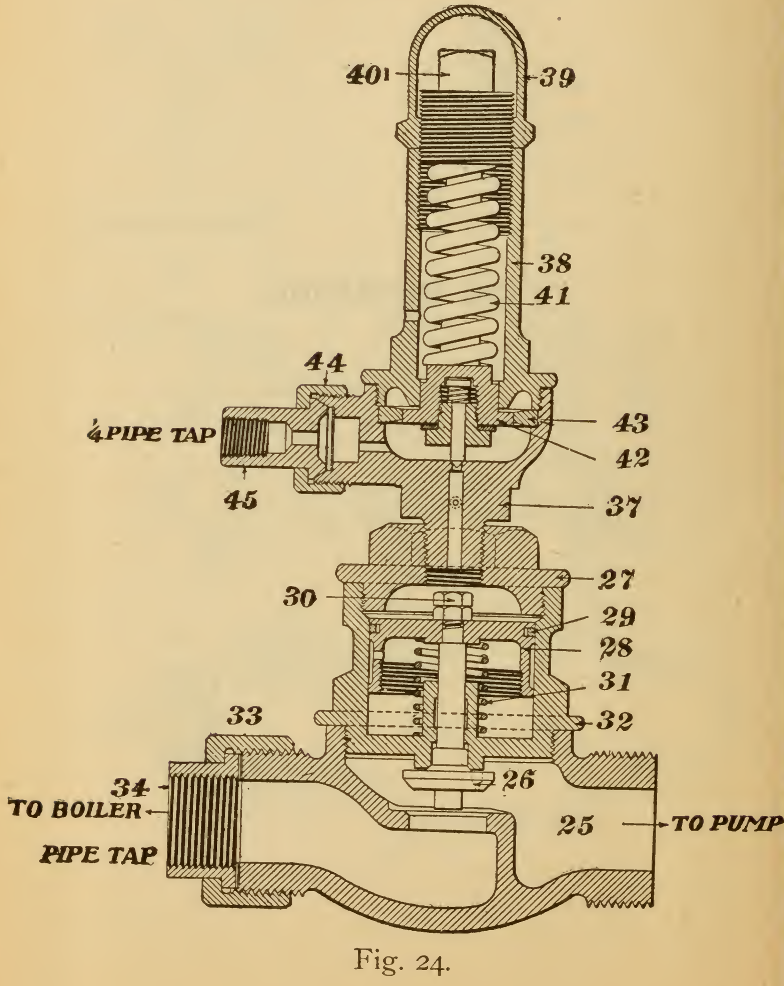


Fig. 24.

ONE-INCH PUMP GOVERNOR.

25 Steam valve body.
26 Steam valve.
27 Cylinder cap.
28 Governor piston.
29 Piston packing ring.
30 Governor piston nut.
31 Governor piston spring.
32 Steam valve cylinder.
33 One inch union nut.
34 One inch union swivel.
35 Waste pipe stud.
36 Waste pipe union nut.
37 Diaphragm body.
38 Spring box.
39 Check nut.
40 Regulating nut.
41 Regulating spring.
42 Diaphragm.
43 Diaphragm ring.
44 Union nut.
45 Union swivel.

A. Air pressure is admitted to the chamber above the governor piston forcing the latter, together with the steam valve, downward until the steam valve closes the steam port leading to the air pump.

Q. How is the amount of air pressure, carried in the air brake system, regulated?

A. By the regulating screw in the top of the governor by means of which the tension of the spring above the diaphragm and air valve is increased or decreased.

Q. How does this regulating spring regulate the amount of air pressure carried?

A. Air pressure must be admitted to the chamber above the governor piston in order that the latter may operate upon the steam valve and close it. Before any air can enter the governor air-chamber the diaphragm and air valve must be forced upward, and this can be done only when the air pressure in the valve chamber of the governor is sufficient to overcome the resistance of the regulating spring bearing downward against the diaphragm.

Q. When the air pressure falls below that at which the governor is set, how does the latter permit the pump to start again?

A. As soon as the air pressure falls a little below that at which the regulating spring in the governor is adjusted, the diaphragm and air valves are forced to their normal position closing the air passage between the diaphragm chamber and the air chamber above the governor piston; after the supply of air is cut off by the air valve from the governor piston the air that remains in this chamber is allowed to escape to the atmosphere through a small vent in the governor body thus relieving the pressure on top of the governor piston, and the steam pressure bearing upward against the valve raises the latter, and opens the steam passage to the pump.

Q. To which air pressure should the pump governor be connected?

A. With the New York engineer's brake valve and Westinghouse D 8 valve it should be connected to train pipe pressure. With Westinghouse D 5, E 6, F 6 and G 6 brake valves to main reservoir pressure. Mr. Dickson answers the above question as follows: "With the New York engineer's brake valve to the chamber which receives pressure from the main reservoir through the excess pressure valve except in full release when it is then in direct connection with the main reservoir."

Q. When connected to the train pipe pressure or to New York valve how should it be adjusted?

A. When connected to the train pipe pressure it should be adjusted to stop the pump when the correct pressure has been obtained in the train pipe, generally at seventy pounds.

Mr. Dickson adds: "The same when connected to the New York valve."

Q. When connected to the main reservoir pressure how should it be adjusted?

A. It should then be adjusted to stop the pump when full main reservoir pressure has been obtained which is generally twenty pounds greater than the train pipe pressure.

Q. What regulates the train pipe pressure with the D 5 and G 6, or latest Westinghouse, brake valve?

A. With the D 5 valve, the feed valve or train line governor; with the G 6, the slide feed valve attachment.

Q. Why should the governor be adjusted ordinarily to permit no more than seventy pounds pressure to accumulate in the train pipe?

A. Because the foundation brake gear of all cars and engines is adjusted to develop the proper braking force from a pressure of seventy pounds in the train pipe and auxiliaries; if more than this were carried there would be a strong likelihood of sliding wheels, and if less the full braking force could not be obtained.

Q. What would be the effect on the operation of the New York governor if gum were to accumulate on the air valve seat?

A. It would have a tendency to decrease the lift of the air valve, and less air could go through to the governor piston, and on this account the governor would permit the pump to accumulate more pressure than it was intended to carry in the train pipe.

Q. What is usually defective about pump governors when they stop the pump and then do not permit it to go to work until after the air pressure has considerably reduced?

A. The air valves leak, and permit pressure to flow continuously into the governor piston chamber and prevent it from rising, or the vent is stopped up.

Q. If a good working pump having a New York governor decreases in speed daily at a gradual rate where would you look for the trouble?

A. This peculiar trouble could be caused by an accumulation of sediment around the stem of the steam valve.

Q. What is generally the cause of pump governors failing to stop the pump when standard pressure has been accumulated in the main reservoir and the train pipe?

A. Most likely the waste port in the governor body, intended to relieve all pressure that might accumulate under the governor piston, is stopped up. This is not likely to happen except in cold weather. Mr. Gesner adds: "If a pipe is attached to the nipple." Or it may be that the air pipe connected to the governor is stopped up so that air cannot get to the governor. Very often small passage below the

WESTINGHOUSE DUPLEX PUMP GOVERNOR.

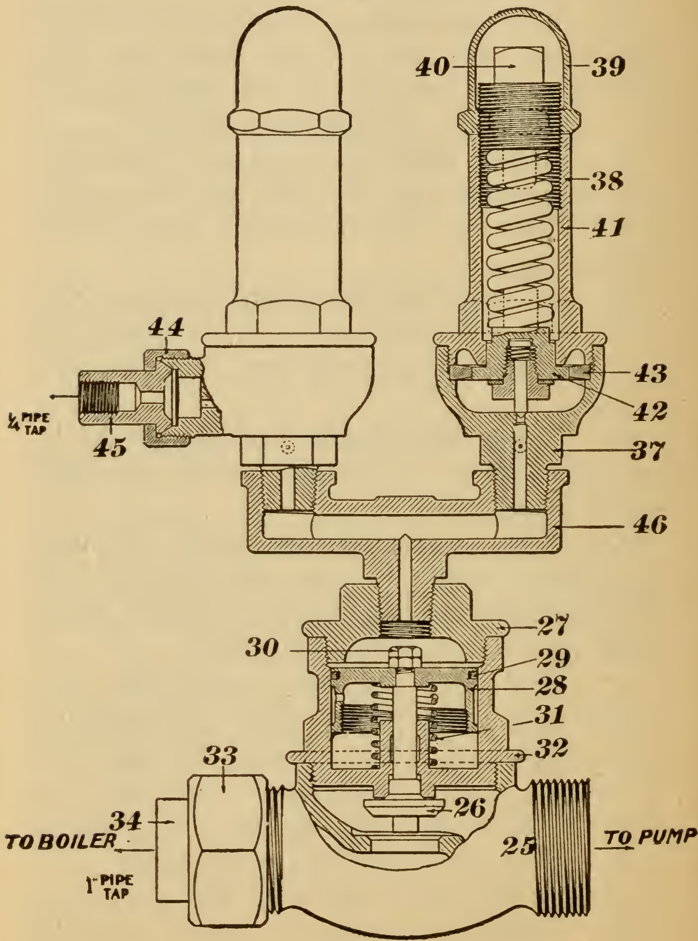


Fig. 25.

DUPLEX PUMP GOVERNOR.

25 Steam valve body.
26 Steam valve.
27 Cylinder cap.
28 Governor piston.
29 Piston packing ring.
30 Governor piston nut.
31 Governor piston spring.
32 Steam valve cylinder.
33 One inch union nut.
34 One inch union swivel.
35 Waste pipe stud.
36 Waste pipe union nut.
37 Diaphragm body.
38 Spring box.
39 Cap nut.
40 Regulating nut.
41 Regulating spring.
42 Diaphragm.
43 Diaphragm ring.
44 Union nut.
45 Union swivel.
46 Siamese fitting.

NEW YORK DUPLEX GOVERNOR.

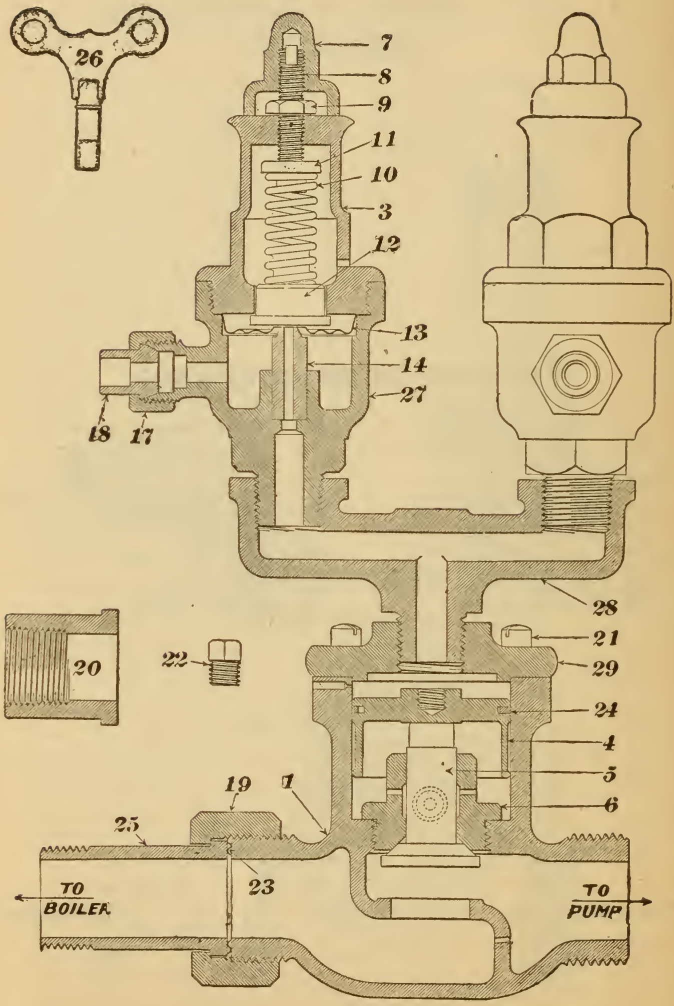


Fig. 26.

DUPLEX PUMP GOVERNOR.

1 Steam valve body.
3 Spring casing.
4 Piston.
5 Steam valve.
6 Steam valve guide.
7 Cap.
8 Adjusting screw.
9 Jam nut.
10 Regulating spring.
11 Upper spring washer.
12 Diaphragm button.
13 Diaphragm.
14 Air valve seat.
17 Air union nut.
18 Air union swivel.
19 Steam union nut.
20 Steam union swivel.
21 Screw.
22 Drain plug.
23 Steam union gasket.
24 Piston ring.
25 Steam union swivel.
26 Key.
27 Diaphragm body.
28 Siamese fitting.
29 Cylinder cap.

air valve gums up and air cannot get to the piston.

Q. What causes gum to accumulate around the air valve seats of pump governors?

A. Whenever there is leakage past these seats there is considerable expansion of the air, which causes it to cool rapidly, and this rapid cooling of the air causes the moisture and oil vapor that it contains to precipitate and lodge on the air valve seat and in the air passage to the governor piston.

Q. What is the duplex pump governor?

A. It is the form of governor used with high pressure-control and with high-speed brakes, and is now the standard form of governor used with the New York engineer's brake valve, whether for the ordinary standard pressure brake, or high pressure control.

Q. Why is it called the duplex governor?

A. Because it has two pressure tops that are connected to a single governor piston body by what is usually termed a siamese coupling or fitting.

Q. How are these pressure tops adjusted?

A. In the same manner as the single top governor; that is, by simply increasing or decreasing the tension of the regulating springs by screwing down or screwing up the adjusting screw.

Q. What pressures do the duplex pump governor control?

A. When only standard pressure is used to operate the brakes, one governor top is piped to the train pipe pressure and controls it; the other governor top is piped to the main reservoir pressure and controls it.

Q. When the duplex governor is used in this way at what pressures are the tops adjusted to act?

A. The top piped to the train pipe pressure is adjusted to seventy pounds and the top piped to the main reservoir pressure is adjusted to one hundred or one hundred and ten pounds, depending something on the size of the main reservoir.

Q. Is the excess pressure valve operative in the brake valve that is supplied with the duplex governor?

A. Yes, when the brake is applied the pump is allowed to pump up pressure in the main reservoir until the main reservoir governor top acts to shut off steam from the pump and stop it, when the brake is released the excess pressure valve operates in the usual way, when the handle of the brake valve is in the running position, then the train pipe governor top acts when seventy pounds pressure has been obtained in the train pipe, and stops the pump.

Q. How are the governor tops adjusted for the high pressure control system?

A. Usually, with the Westinghouse equipment, one governor top is adjusted to stop the pump when one hundred and ten pounds pressure has been obtained in the main reservoir and one top is adjusted to stop it when ninety pounds pressure has accumulated in the main reservoir. With the New York equipment one governor top is adjusted to operate when ninety pounds pressure have been obtained in the train pipe, and one is adjusted to operate when seventy pounds are obtained in the train pipe.

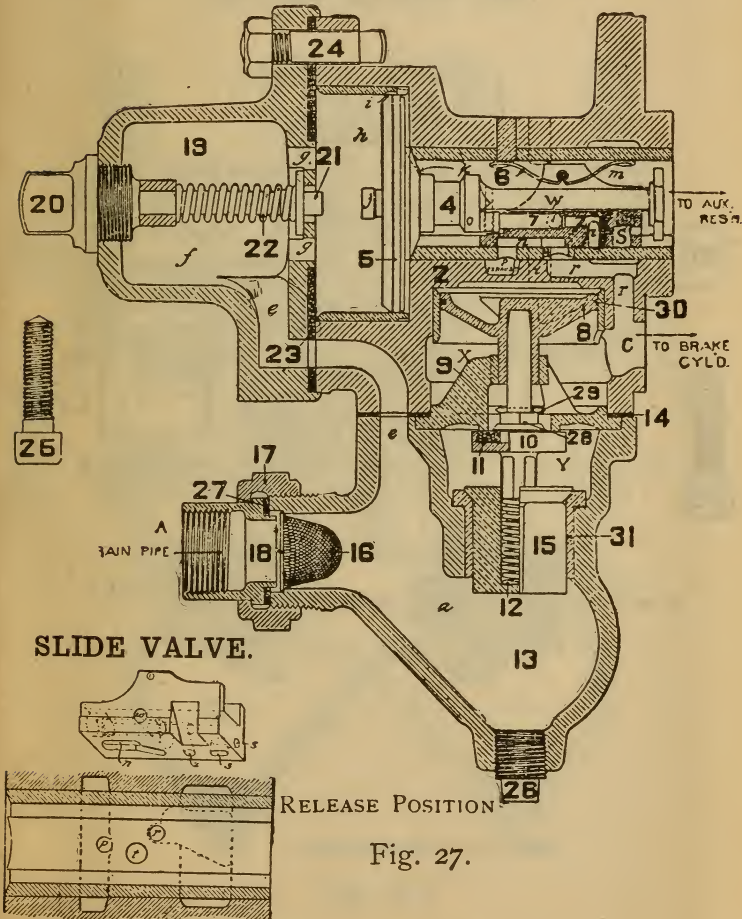
Q. Then both governor tops of the duplex governor are piped to the same pressure, when used with the high pressure control system?

A. Yes; and the high pressure or standard pressure may be had at will by simply closing or opening a stop cock in the pipe leading to the standard pressure governor top.

Q. Are duplex governors likely to render better service when used with the standard pressure than the single top governor?

A. Yes; on account of the ability to obtain any pressure desired in the main reservoir while the brakes are applied, while only the ordinary ninety pounds pressure is carried, when the brakes are released and the handle of the brake valve is in the running position. Mr. Dickson says: "No matter what position the handle of the brake valve is in."

WESTINGHOUSE QUICK ACTION PASSENGER TRIPLE VALVE.



SLIDE VALVE.

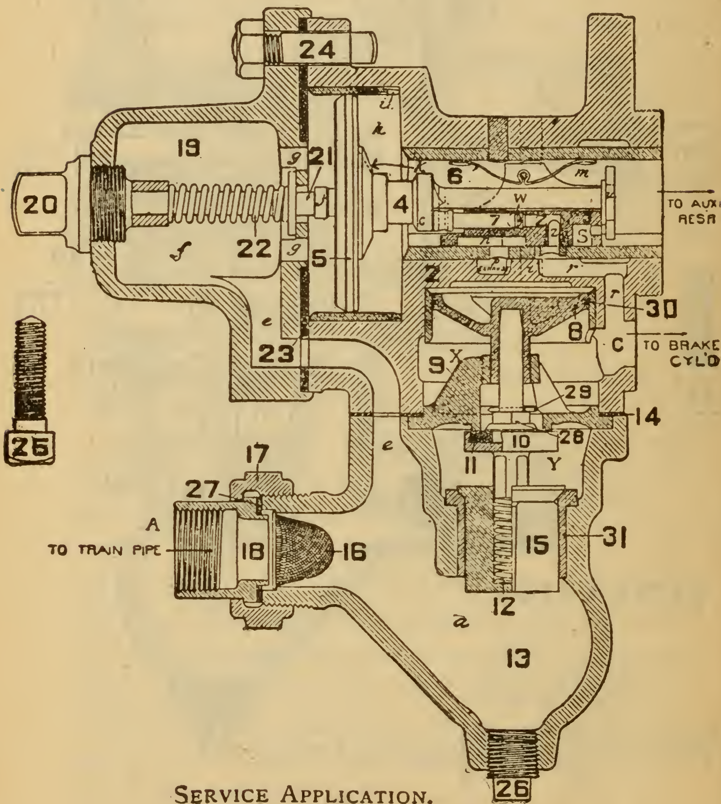
RELEASE POSITION

Fig. 27.

SLIDE VALVE BUSHING.

L. of C.

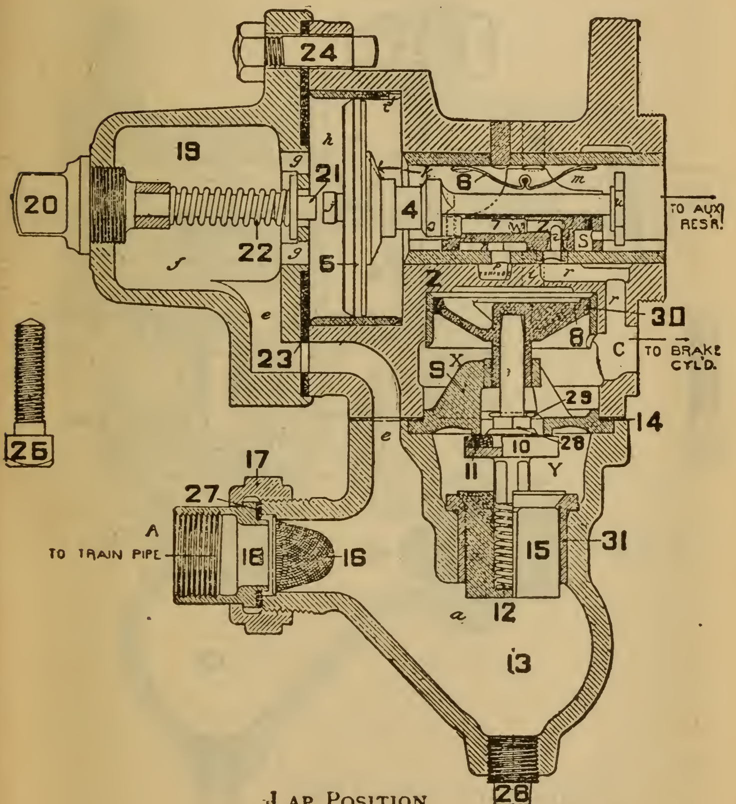
WESTINGHOUSE QUICK ACTION PASSENGER TRIPLE VALVE.



SERVICE APPLICATION.

Fig. 28.

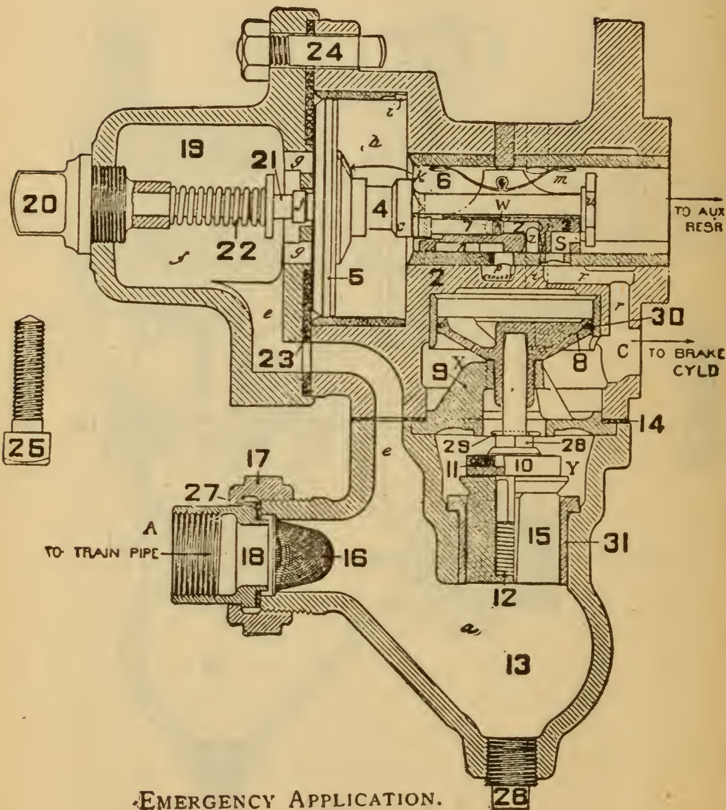
WESTINGHOUSE QUICK ACTION PASSENGER TRIPLE VALVE.



LAP POSITION.

Fig. 29.

WESTINGHOUSE QUICK ACTION PASSENGER TRIPLE VALVE.



EMERGENCY APPLICATION.

Fig. 30.

QUICK ACTION PASSENGER TRIPLE VALVE.

2 Triple valve body.
3 Slide valve.
4 Piston.
5 Packing ring.
6 Slide valve spring.
7 Graduating valve.
8 Emergency valve piston.
9 Emergency valve seat.
10 Emergency valve.
11 Rubber seat.
12 Check valve spring.
13 Check valve case.
14 Check valve case gasket.
15 Check valve.
16 Strainer.
17 Union nut.
18 Union swivel.
19 Cylinder cap.
20 Graduating stem nut.
21 Graduating stem.
22 Graduating spring.
23 Cylinder cap gasket.
24 Bolt and nut.
25 Half inch cap screw.
26 Half inch plug.
27 Union gasket.
28 Emergency valve nut.
29 Cotter pin.
30 Emergency valve piston packing ring.

TRIPLE VALVES.

Q. To what is the train pipe connected under each car?

A. To the triple valve.

Q. What else besides the train pipe is connected to the triple valve?

A. The auxiliary reservoir and the brake cylinder.

Q. How many forms of triple valves are there in use?

A. Two; the plain and the quick action.

Q. Which is the simpler form of the triple valve?

A. The plain triple.

Q. What are the working parts of the plain triple valve?

A. A piston valve, a slide or exhaust valve and a graduating valve.

Q. What are the duties of the triple-piston?

A. To cover and to uncover the feed groove of the triple cylinder, which affords the means of charging the auxiliary reservoir with air from the train pipe, and to move the slide and the graduating valves.

Q. How does the air from the train pipe get into the auxiliary reservoir?

A. It passes through the charging groove, cut on the upper extreme forward portion of the triple cylinder, when the triple piston valve is in the release position.

Q. What are the duties of the slide or exhaust valve?

A. To open and close the service port leading from the auxiliary reservoir to the brake cylinder.

Q. How is the triple-piston operated?

A. It is operated by means of the difference between the train-pipe and auxiliary reservoir pressure, acting upon the other side, and it always moves in the direction of, or toward, the weaker pressure.

Q. When the train pipe and the auxiliary reservoir are charged up to normal pressure, how do the pressures compare on either side of the triple piston valve?

A. They are equal.

Q. In which direction must the triple piston valve move in order to apply the brakes?

A. It must move in the direction toward the train pipe pressure.

Q. How is it made to move in this direction?

A. By reducing the train pipe pressure below the pressure in the auxiliary reservoir. As soon as the train pipe pressure falls below the auxiliary reservoir pressure, the latter being stronger will force the triple piston in the direction of the reduced train pipe pressure, and in moving in this direction the triple-piston valve first closes the feed-groove in the triple cylinder cutting off communication between the train pipe and the auxiliary, and then moves the exhaust slide valve to the position which closes the exhaust port leading from the brake cylinder to the atmosphere, and the graduating valve to the position which opens the service port, allowing the auxiliary reservoir pressure to expand into the brake cylinder and so, by means of the piston in the latter and the foundation brake gear, apply the brake.

Q. If the train-pipe pressure should be reduced five pounds below auxiliary reservoir pressure, how much would the latter pressure reduce by expansion into the brake cylinder?

A. About the same amount—five pounds.

Q. Why would not the auxiliary reservoir pressure continue to reduce?

A. Because as soon as the auxiliary pressure falls a trifle below the train pipe pressure, the latter then being a trifle stronger will force the triple-piston valve in the other direction, that is, toward the auxiliary reservoir pressure, until the graduating valve closes the service port, thus lapping the valve and leaving the pressures bearing against the triple piston valve about equal.

Q. When the triple piston moves toward the release position far enough to move the graduating valve to lap position, does it also move the exhaust slide valve?

A. No; after the first movement to application position, the exhaust slide valve does not move again until the triple valve goes to release position.

Q. If more pressure is required in the brake cylinder than was obtained from the first train pipe reduction of four pounds what must be done?

A. The train pipe pressure must be further reduced.

Q. When a second reduction is made what parts of the triple valve operate?

A. The triple piston valve and the graduating valve; they move to the application returning to lap position again as soon as the auxiliary pressure has reduced an amount practically equal to the reduction made in the train pipe pressure.

Q. When the brake is applied with full force how does the pressure in the brake cylinder and that in the auxiliary reservoir compare?

A. They are equal.

Q. How much must the train-pipe pressure be reduced to apply the brake with full force?

A. About twenty-three pounds. Mr. Gesner says: "With standard piston travel." Mr. Roach says: "According to piston travel."

Q. Why will not a greater reduction than this apply the brake with increased force?

A. Because the size of the auxiliary reservoir and the size of the brake cylinder are so proportioned to each other that when a wide open communication exists between them, the auxiliary reservoir pressure can only reduce about twenty pounds by expanding into the brake cylinder; that is, the pressure in each will equalize at about fifty pounds from an initial pressure of seventy pounds and a piston travel of eight inches. Mr. Roach adds: "depending on the travel of the piston."

Q. How is the brake released?

A. By making the train pipe pressure greater than the auxiliary reservoir pressure. This is done either by moving the handle of the brake valve to the full release position, and admitting main reservoir pressure to the train pipe, or by opening the release valve on the auxiliary reservoir, and allowing the pressure in the latter to escape to the atmosphere.

Q. How is it that increasing the train pipe pressure over the auxiliary pressure will cause the brake to release?

A. When the train pipe pressure is greater than the auxiliary reservoir pressure the triple piston will be forced over to the release position carrying with it the slide and the graduating valves. In the release position, the slide valve uncovers the exhaust port, and permits the brake-cylinder pressure to escape to the atmosphere, thus releasing the brakes.

Q. How is the auxiliary reservoir pressure re-charged?

A. When the triple-piston valve is in the release position, the charging groove is uncovered, and air from the train pipe can pass into the auxiliary reservoir until the pressure in the latter is equal to that in the train pipe.

Q. Is it possible to operate the plain and the quick-action triple valves together in the same train and have them work satisfactorily?

A. Yes.

Q. How must the brakes be applied to have them do this?

A. They must be applied gradually.

Mr. Davis says: This would hardly do on elevated roads where stops are frequent as it would consume too much time.

Q. Will these two types of triples do the same work in gradual applications?

A. Yes; for the same parts in each operate in an ordinary application of the brake.

Q. What are these parts?

A. They are the triple piston valve, the slide or exhaust valve, and the graduating valve. It is the combination of these three valves that constitute the triple valve.

Q. In what way is the quick-action triple valve different from the plain triple?

A. In that it has an additional, or supplementary set of valves which are used for the purpose of venting the train pipe air and admitting air quickly to the brake cylinder in emergency applications.

Q. Why is it desirable to have the triple valve vent the train-pipe air locally in emergency applications?

A. In order to hasten the operation of all the triple valves throughout the whole train, and make a quicker application of all the brakes.

Q. How are the quick-action valves put in operation?

A. By a quick reduction in train pipe pressure.

Q. Does it require a heavy reduction in train-pipe pressure to cause the quick-action parts of the triple to go into action?

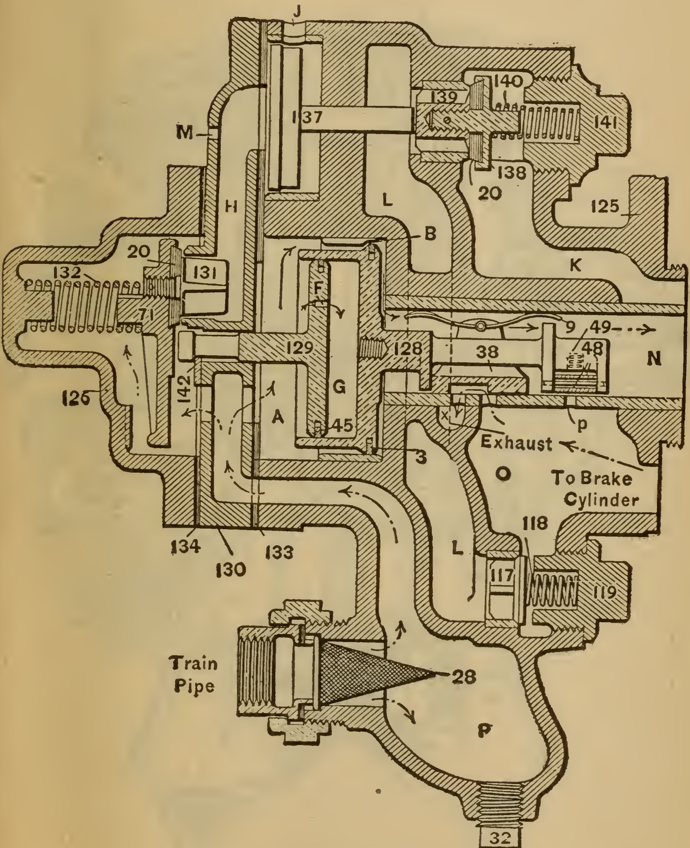
A. No; not exactly; the essential thing to cause quick-action is a quick reduction in train-pipe pressure.

Q. Aside from the fact that quick-action triple valves apply the brakes quicker in emergencies, what other reason is there for their use?

A. In making emergency applications quick-action of the triple cause the brakes on the rear cars to apply so soon after the head brakes apply that they prevent the rear of the train from running up hard against the front, on which the brakes apply first, and so prevent serious shock to the rear end. Mr. Gesner adds: "And with the Westinghouse apparatus the brakes are applied with greater force."

Q. If several triples in succession were located close to the front end of the train, and

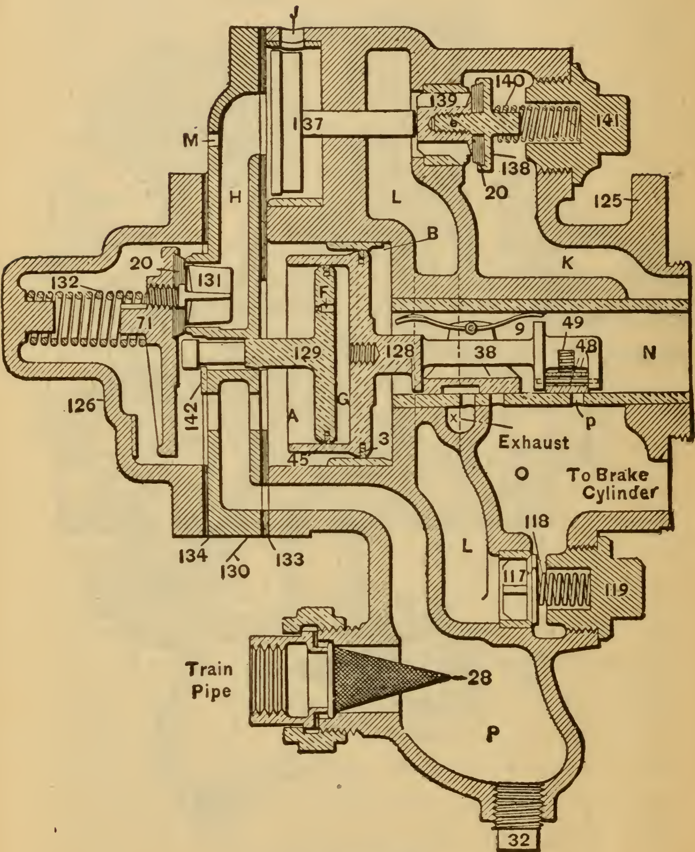
NEW YORK QUICK ACTION TRIPLE VALVE.



RELEASE POSITION.

Fig. 31.

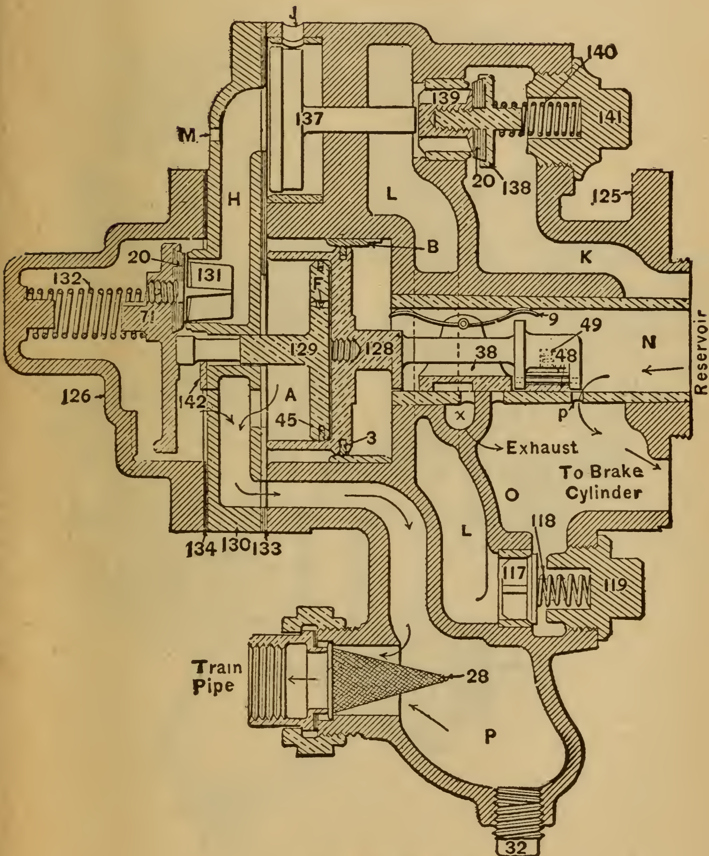
NEW YORK QUICK ACTION TRIPLE VALVE.



LAP POSITION.

Fig. 32.

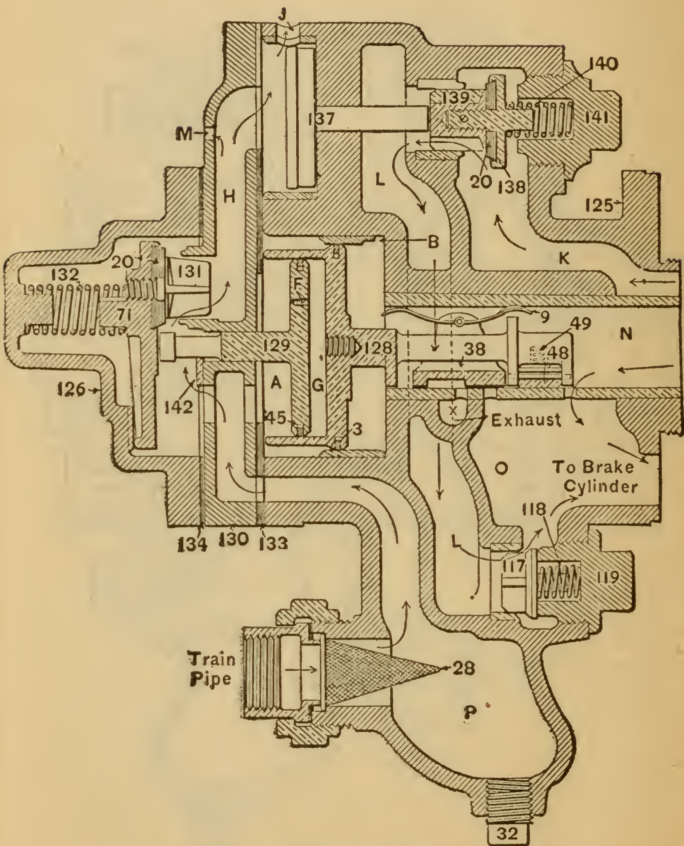
NEW YORK QUICK ACTION TRIPLE VALVE.



SERVICE POSITION.

Fig. 33.

NEW YORK QUICK ACTION TRIPLE VALVE.



Emergency Position.

Fig. 34.

QUICK ACTION TRIPLE VALVE.

3 Main piston ring.
9 Slide valve spring.
20 Rubber valve seat.
28 Strainer.
29 Union nut.
30 Union swivel.
31 Union gasket.
32 Drain plug.
38 Slide valve.
45 Vent valve piston ring.
48 Graduating valve.
49 Graduating valve spring.
53 Exhaust hole plug.
71, 131, 20 Vent valve.
117 Check valve.
118 Check valve spring.
119 Check valve cap.
125 Triple valve body.
126 Front cap.
127 Side cap.
128 Main piston.
129 Vent valve piston.
130 Vent valve seat.
132 Vent valve spring.
133 Main cylinder gasket.
134 Front cap gasket.
135 Front cap bolt.
136 Side cap bolt.
137 Quick-action valve piston.
138, 139, 20 Quick-action valve.
140 Quick-action valve spring.
141 Quick-action valve cap.
142 Piston stop.
143 Piston stop screw.

were cut out, could the quick-action mechanism of those triples behind them be made to operate in an emergency application?

A. It is doubtful; on account of each succeeding triple depending upon the one in front of it for the quick-reduction in train-pipe pressure to throw its quick-action into operation, it is likely that the reduction, by the time it reached the first active triple valve behind the four inactive, or cut out triples, would be so weakened as to fail to start the quick action in this triple, and so quick-action would fail on all cars behind those with the cut out triples.

Q. What other causes besides a number of triple valves in succession cut out can cause failure of quick-action to result in emergency applications?

A. Very crooked piping, especially if it contains numerous short elbows, or several plain triple valves placed in succession near the front of the train would cause quick action to fail. Mr. Gesner adds: "If the brakes were applied from the head end of the train."

Q. Should a partial service application of the brakes be made and then the handle of the brake valve were placed in the emergency position could quick-action be obtained?

A. It is very doubtful. After the service application has begun the New York triples do not usually go into quick-action, and the Westinghouse triples go into quick-action or not, depending on the amount of pressure already in the brake cylinder, and the length of the train pipe.

Q. It has been claimed, that to recharge the auxiliary reservoir it is necessary for the triple valve to be in the release position. Is there any way that the auxiliary can be recharged and not release the brake?

Q. Yes; with the assistance of the pressure-retaining valve, an auxiliary may be recharged without entirely releasing the brakes. Mr. Roach adds: "but the triple must be in release position, unless the piston packing ring leaks very badly."

Q. What is the principal difference between the Westinghouse and the New York plain triple valves?

A. The Westinghouse plain triple has a graduating valve of the poppet type, while the New York plain triple has a graduating valve of the slide valve type. The Westinghouse triple has a longer stroke in the emergency application than in the service, and has a graduating spring to assist the piston in making the proper stroke in the service application. The New York triple has the same stroke in the emergency application as in the service, and does not require a graduating spring.

Q. What additional parts are necessary in the Westinghouse type to produce quick-action?

A. *A non-return brake cylinder check valve;* an emergency valve, an emergency piston, and a suitable casing to contain them.

Q. What additional parts are necessary in the New York triples to produce quick-action?

A. A vent piston, a vent valve, an emergency valve, an emergency piston and a brake cylinder check valve.

Q. How does a sudden reduction in train-pipe pressure cause the New York triple to operate in quick-action?

A. Between the triple piston and the vent valve piston there is a chamber formed which is filled with air at the same pressure as that in the train pipe. The air in this chamber can escape only through the small port F in the vent-piston, and in the service application the pressure in this chamber can reduce along with the train pipe pressure at about the same rate, so that no part of the quick-action portion of the triple is put in operation. When a sudden reduction is made in train pipe-pressure, the pressure in the chamber between the triple piston and the vent-valve piston can not reduce through the small port so rapidly as train pipe pressure reduces, and so the triple piston cushions on the air in the vent piston chamber with the result that the vent piston is forced out in the same direction as the triple piston. When the vent piston is forced forward in the manner described above its stem strikes against the vent-valve lever arm, forcing the vent valve from its seat, and thus allows train pipe air to escape to the atmosphere.

Q. What effect does the venting of train pipe air in this way have on the other quick-action triples that are next to the venting triple in the train?

A. It produces a quick reduction in train pipe pressure near those triples that causes them to operate in quick-action. Each quick-action triple in the train is dependent upon those in front of it for the sudden reduction in train-pipe pressure to throw its quick-action valves into operation.

Q. After the vent-valve has been thrown open by the action of the vent-valve piston, what duty does the escaping air have to perform while on its way to the atmosphere?

A. It must strike against the emergency piston, and force it over until its stem bears against the emergency valve and forces the latter from its seat.

Q. When the emergency valve is forced away from its seat what occurs?

A. The auxiliary pressure, which is always behind the emergency valve, is admitted through a large passage in the triple body to the brake cylinder, and equalizes with the brake cylinder pressure almost constantly.

Q. What is required to throw the quick-action valves in the Westinghouse triple into operation?

A. A quick reduction in train pipe pressure.

Q. How does a quick reduction in train pipe pressure accomplish this?

A. A quick reduction in train pipe pressure causes the triple piston to move its full stroke, bringing the slide valve into a position where it uncovers the emergency port in its seat. When the emergency port is uncovered the auxiliary reservoir pressure rushes through it into the top of the emergency piston, forcing the latter down, which in turn, by means of its stem, forces the emergency valve away from its seat, after which the train pipe pressure raises the non-return check valve and vents directly into the brake cylinder.

Q. Then in emergency applications there is some gain in pressure in the brake cylinder, when a Westinghouse triple operates in quick-action?

A. Yes.

Q. About how much pressure is gained from the air that is vented from the train pipe into the brake cylinder?

A. The amount of gain in pressure depends on the size of the brake cylinder and the travel of the brake cylinder piston. The larger the brake cylinder and the longer the piston travel the less the gain.

Q. Then the larger the brake cylinder, the less gained in pressure in emergencies from the train pipe air?

A. Yes; the volume of the train pipe being always about the same, it follows that the pressure obtained in the brake cylinder must be less as the brake cylinder gets larger. Mr. Gesner says: "but it can be largely increased by shortening the piston travel." Mr. Roach says that a good answer would be: "About twenty per cent in emergency."

DEFECTS OF THE WESTINGHOUSE TRIPLE.

Q. Should the graduating valve leak how could it be determined?

A. When the triple valve is on lap position, after a partial service application has been made, it is likely to manifest its leaky condition by releasing the brakes. Mr. Dickson adds: "The slide valve is leaking also."

Q. Will a leaky graduating valve in either the Westinghouse or the New York triple always cause the brakes to release after a partial service application has been made?

A. Not always; if the triple piston packing rings leak at the same time it is likely that the brake will remain applied.

Q. If the slide valve leaks, how can it be known?

A. If the slide or exhaust valve leaks it will be known by a blow at the exhaust port in the body of the triple, both when the brake is applied and when it is released.

Q. What effect does a leaky slide valve have on the brake?

A. It will allow the brake to let off gradually and the triple valve to move to the release position, after which if the brakes be applied partially in service it will cause the other brakes in the train to apply with increased force.

Q. What is the effect of a leaky triple piston packing ring?

A. A leaky triple piston packing ring is likely to cause the brake to fail to release, especially if the engineer fails to make the release with the handle of the brake valve in the full release position, and the train consists of many cars. Mr. Gesner says: "And the defective ring should be near the rear end."

Q. What is the effect of a triple piston ring that is too tight?

A. It makes the triple valve slow to respond to light reductions in train pipe pressure, and sometimes to go to emergency position after a sufficient reduction has been made to move it, and immediately of its own accord, return to release position.

Q. What effect does a dirty charging groove have on charging the auxiliary reservoir?

A. It retards the recharging of the auxiliary, and sometimes prevents the brake from applying along with the others when the test application is made.

Q. Will dirty strainers in the union of the triple body and the train pipe cause this same trouble?

A. They will, and in addition will cause the application of the brakes to be very sluggish and sometimes prevents its application entirely.

Q. What is the effect of a dirty, gummy triple valve?

A. It will often work in quick-action when it is intended to have it operate in service.

Q. Suppose the rubber seated emergency valve is leaking, how can it be known?

A. If the rubber seat of the emergency valve is leaking it will cause a blow at the exhaust port or through the retaining valve while the triple is in the release position, that will cease the moment the brake is applied.

Q. Would not a leak in the check valve case gasket between the train pipe chamber and emergency valve chamber produce the same kind of blow?

A. Yes; it would have the same effect. Mr. Roach says: "The check valve would not, as the rubber seated valve would be on its seat, but it would release the brake after emergency application."

Q. What are the serious effects of leaky emergency valves and check valve case gaskets?

A. They allow train pipe pressure to flow into the brake cylinder and raise the pressure so high in the latter, in all light service applications, as to cause the wheels to slide in many instances.

Q. What other bad effects do these leaks have?

A. They have a tendency to cause the brakes to fail to release, especially on light service applications.

Q. What effect do leaky non-return brake cylinder check valves have on the operation of the brakes?

A. When the piston travel is irregular on the different cars in the train; varying between the extreme long and the extreme short travel, there is a likelihood of back leakage from the brake cylinder of the short piston raising the pressure in the train pipe sufficiently to release the brakes having long piston travel. In emergency applications leaky non-return check valves will allow the brakes to weaken and to leak off.

Q. What effect does a weak or broken graduating spring have on the operation of the triple?

A. It will, on short trains, cause the triple to work in quick-action, when a service application is being made.

DEFECTS OF THE NEW YORK TRIPLE.

Q. How can a leaky graduating valve in the triple valve be detected?

A. If a graduating valve in the triple valve is leaking, there will be a constant blow at the exhaust port while the brake is released which will cease as soon as the brake is applied.

Q. How does a leaky slide valve manifest itself?

A. By a constant blow at the exhaust port, both when the brake is applied and when it is released.

Q. What effect does a leaky graduating valve have upon the operation of the triple?

A. It is likely, if the brake is applied in a partial service application, to release it, although whether it will release the brake or not depends on the general condition of the triple, as a whole, and the amount of leakage in the train pipe.

Q. What effect will a leaky exhaust have on the operation of the triple?

A. It will cause the brake to leak off.

Q. If a blow was heard issuing from the two square vent ports in the triple valve body under the emergency cap, could you determine which valve in the triple was leaking?

A. Yes.

Q. How could you do this?

A. First, I would know that all leaks of the exhaust and the graduating valves as well as some of those of the gaskets between the auxiliary and the triple body, or the brake cylinder head and triple body as the case might be, go into the passage leading to the brake cylinder, and make their escape to the atmosphere through the exhaust port to the triple valve body; second, that all leaks of the valves comprising the quick-action feature are manifested at the vent ports at the side of the triple body under the emergency cap; third, that if the brake were applied a leak from the brake cylinder past the brake cylinder check valve would also be manifested at the two square holes under the emergency cap. Therefore, I would know that if a blow was coming from the two square holes under the emergency cap while the brake was released, it was the emergency valve which was leaking, while if a blow was heard from these same holes while the brake was applied, that ceased as soon as the brake was released, I would know that it was the brake cylinder check valve that was leaking.

Q. Suppose it is the vent valve that is leaking, how would you distinguish this leak from that of the emergency valve or the brake cylinder check valve?

A. If the vent valve is leaking it can always be readily and quickly ascertained by placing the finger over the small port just back of the two exhaust ports, at the side of the triple valve body.

Q. What effect will a leaky emergency valve have on the operation of the brakes?

A. A leaky emergency valve will permit the auxiliary reservoir pressure to escape to the atmosphere, and this, while the brake is released, will have the same effect as any other leak in any other part of the air brake system; namely, it will be a waste of air, and it will make the pump work harder to supply the required pressure; and while the brake is applied it will produce the same effect as a leaky release valve, namely, it is likely to release the brake on the particular car on which it is located, and to cause the brakes on all the other cars, if not already fully applied, to apply with full force.

Q. What effect will a leaky brake cylinder check valve have on the operation of the brake?

A. It will cause the brake to leak off slowly.

Q. What effect does a leaky vent valve have on the operation of the triple?

A. As the vent valve has train pipe pressure behind it, any leak past this valve, will, while the brakes are applied, cause a reduction in train-pipe pressure, and will, unless they are already fully applied, cause them to set with full force; while brakes are released, it will be a simple leak from the train pipe which will make it necessary for the pump to work a little harder to keep up the standard pressure.

Q. What is the object of having a large spring behind the vent valve?

A. The vent spring is placed behind the vent valve to assist the train pipe pressure to force it to its seat, and also, by means of the lever arm of the vent valve, to move the vent valve piston back to its normal position, after quick-action has taken place.

Q. Suppose the vent valve spring should break, what would be the probable effect?

A. It is probable that after the emergency action of the triple had taken place, as in an emergency application, the vent valve would not close so promptly as it otherwise would if the vent valve spring were all right, and possibly in a service application quick-action might result when only a service application was desired.

Q. What kind of facings are used on the emergency and the vent valves?

A. They are made of rubber.

Q. In case an emergency valve becomes defective, how can it be removed for cleaning and repairs?

A. By unscrewing the upper cap nut at the side of the triple body.

Q. What precaution should be taken before this cap nut is removed?

A. The defective triple should be cut out from the rest of the train by closing the cut-out cock in the cross-over pipe and all the air should be "bled" from the auxiliary reservoir.

Q. Should this same precaution be taken before attempting to remove any of the other parts of the triple valve for cleaning or for repairs?

A. Yes; for all except the brake cylinder check valve.

Q. If the brake cylinder check valve should require attention, how could it be removed?

A. If the brake cylinder check valve leaks, it can do so only while the brake is applied; therefore, when the brake is released, there is no air pressure against it, and the lower cap nut can be unscrewed, without the necessity for cutting out the brake, and the check valve may be removed for inspection and for repairs.

Q. If it is necessary to remove the vent valve for cleaning, or for any purpose, how can this be done?

A. First, cut the brake out as directed above for the emergency valve and relieve the auxiliary of all pressure; then unscrew the three cap nuts and remove the triple cap, in which will be found the vent valve and the vent-valve spring.

Q. When removing the triple cap for the purpose of cleaning the triple valve or examining the vent valve care should be taken to avoid what?

A. Care should be taken in removing the

triple cap not to bend or spring the vent valve piston stem and not to hammer the middle flange, called the vent valve seat, in separating it from the triple cap.

Q. How should the quick-action triple valve be cleaned and oiled?

A. The cross-over pipe should be disconnected from the triple valve, and the conical strainer, which is placed in the union, should be thoroughly cleaned of all accumulation of dirt and foreign matter; then the triple cap being carefully removed, the triple piston, the exhaust valve and the graduating valve should be placed in a vat of kerosene or some other light oil that will cut away the dirt and gum. Care should be taken to work this in around the packing rings and to work the packing rings in their grooves in order that all gum and dirt may be thoroughly worked out, after which all parts should be wiped perfectly dry and a little vaseline rubbed on the wearing surfaces of the slide and graduating valves and around the triple piston and vent valve piston cylinders.

Q. Should the valves having rubber facings ever be oiled?

A. No, never; all they need is cleaning, but never oil.

Q. What is the objection to putting oil on valves which have rubber facings, or on any kind of rubber for that matter?

A. Because oil, if put on any kind of rubber, will rot it out, and, therefore, oil if placed on the emergency or the vent valve would have the same effect, namely, it would rot them and cause them to leak.

Q. Should the packing rings ever be removed from the triple piston or from the vent-valve piston for the purpose of cleaning?

A. They should never be removed from their grooves for this purpose, as there is every likelihood of bending, distorting or breaking them in the operation of removing and replacing. Besides, it is not necessary for the purpose of cleaning, to remove the packing rings, as all the cleaning they require can be accomplished with the packing ring in its groove.

Q. Should all parts of the triple valve be carefully inspected after cleaning and before replacing in the valve body?

A. They should, in order to be certain that all parts are in perfect condition.

Q. What parts should receive particular attention during the replacing in the valve body?

A. It should be observed that the exhaust valve is replaced properly on the piston stem and that it has not been turned wrong end to; that the packing rings work freely in their grooves and that the ends come closely together making a good fit; that the pistons work freely in their cylinders and that none of the parts are sprung or twisted out of shape; and that all gaskets are in good condition.

Q. How should the feed-groove be cleaned?

A. It should be cleaned out with a sharp pointed tool, preferably of wood, and care should be taken never to enlarge this groove or in any way alter its shape or size.

Q. Is it necessary to disconnect any of the pipe unions in order to get to any particular valve of the triple for the purpose of making repairs to it?

A. No; all valves in the triple valve body may be removed for inspection and for repairs without disturbing any part of the piping.

Q. Can the strainer in the New York drain cup be removed for cleaning without disconnecting any of the piping?

A. Yes. By simply unscrewing the removable spider, on which the strainer is mounted, from the top of the drain cup, it may be reached without the necessity of disturbing any part of the piping.

Q. Why is the strainer in the New York drain cup placed above the line of the main train pipe?

A. So that all dirt, missiles and foreign matter that may be rushing to and fro in the pipe along with the currents of air may pass the strainer without striking or injuring it, and to lessen the amount of dirt that will find its way to the triple valve.

Q. Has the combined pipe strainer and car drain cup of the standard New York type proved efficient in preventing dirt from reaching the triple valve?

A. Yes; it has proved very efficient; and also proved superior to any other similar device used for the same purpose.

THE COMBINED FREIGHT-CAR CYLINDER, RESERVOIR AND TRIPLE VALVE.

The Combined Freight-Car Cylinder and Reservoir (Fig. 35) is the usual form of equipment applied to a freight car. Upon some cars the cylinder and auxiliary reservoir are separated, but the triple valve, auxiliary reservoir, and brake cylinder are the same in both cases.

Auxiliary reservoir 10 is simply a hollow shell for the purpose of storing air for use in the brake cylinder upon the same car.

Pipe *b* provides communication between the triple valve and the brake cylinder. Upon passenger cars, this pipe does not pass through the auxiliary reservoir, but the operation of the brake is the same; it is simply a different arrangement of the same parts.

2 is the brake cylinder; 3 is the sleeve in which the push rod, connected with the system of brake levers, is inserted; 4 is the non-pressure cylinder head; 9 is a release spring which forces piston 3 to the release position when the air pressure is released from the pressure end of the cylinder; 7 is a packing leather which is pressed against the cylinder wall to prevent air from escaping past the piston; 8 is a round

COMBINED FREIGHT-CAR CYLINDER, RESERVOIR AND TRIPLE VALVE.

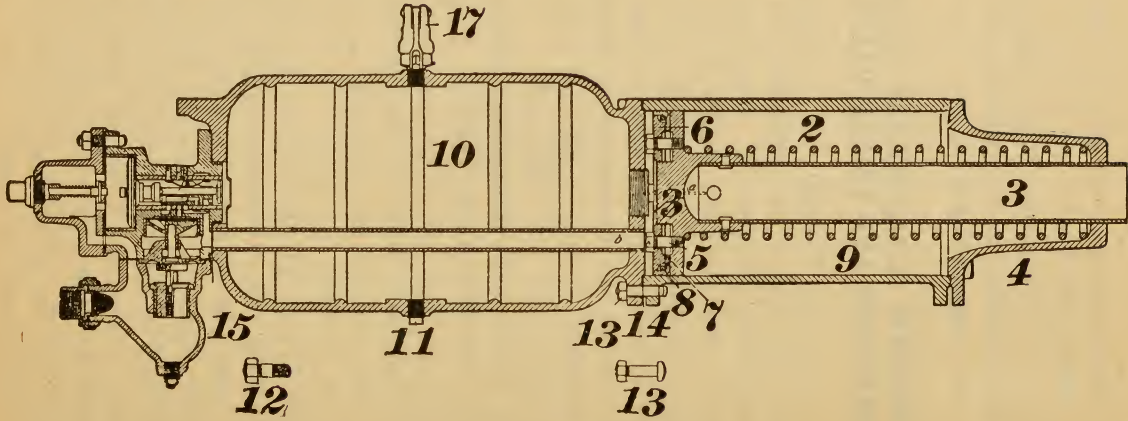


Fig. 35.

spring packing expander which serves to hold the flange of the packing leather against the walls of the cylinder; 6 is the follower plate, which, by means of studs and nuts 5, clamps the packing leather to the piston; and *a* is a small groove (indicated by dotted lines) in the wall of the cylinder, called the leakage groove. If the exhaust port of the slide valve of the triple valve should, in any manner, become obstructed when it is not desired to have the brakes applied, a slight flow of air into the cylinder from any cause will, instead of forcing the piston out, escape through leakage groove *a* to the atmosphere at the non-pressure end of the cylinder. Valve 17, usually placed above the auxiliary reservoir, is known as the release valve. A rod extends from the arms of this valve to each side of the car, and pulling either rod unseats the valve and discharges air from the reservoir for the purpose of releasing the brake.

RELEASE VALVE.

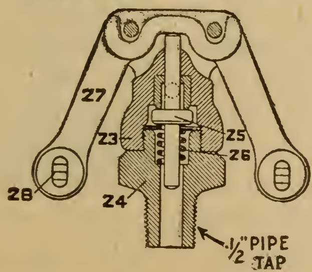


Fig. 36.

23 Release valve cylinder.
24 Release valve stud.
25 Vent valve.
26 Release valve spring.
27 Release valve handle.
28 Release valve pin.

PRESSURE RETAINING VALVE.

Q. What is the pressure retaining valve used for?

A. It is used to retain a certain portion of the brake cylinder pressure in the cylinders to retard the acceleration of the train while descending grades while the auxiliary reservoirs are recharging, and they should always be used on heavy grades.

Q. Are there many of these valves in use?

A. Yes, they are used extensively on freight cars where heavy grades are encountered and some are in use upon passenger trains in mountainous parts of the country.

Q. How much pressure does this valve retain in the cylinder?

A. That is determined by the weight of valve 4 shown in Fig. 37. Usually fifteen pounds per square inch.

Q. Explain the operation of this valve.

A. A pipe is screwed into the triple valve exhaust port which connects with the pressure retaining valve at X in Fig. 37. If the handle 5 be turned down the valve will be inoperative, the air passing through ports B, A and C to the atmosphere, but when the handle is turned horizontally, as shown, then the air will pass from the brake cylinder through the triple valve, retaining valve pipe and ports B, A, b and D, and it must therefore raise valve 4 from

PRESSURE RETAINING VALVE.

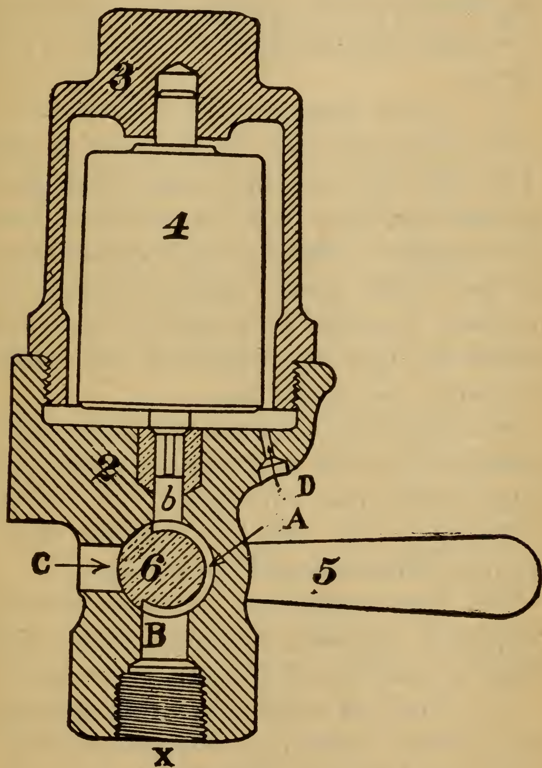


Fig. 37.

its seat to pass to the atmosphere through the small port D, where it will continue to escape until the pressure has been reduced to fifteen pounds, then the weighted valve will close and no more air can escape to port D, the remaining fifteen pounds pressure will be retained in the brake cylinder until the handle 5 is turned down.

Q. What is the size of port D?

A. One-sixteenth of an inch in diameter. The old style retaining valve had two one-quarter inch ports, but it would let the air escape too rapidly. With a one-sixteenth inch port it will take about twenty seconds for the cylinder pressure to reduce to fifteen pounds, which is about the length of time required to recharge the auxiliaries.

Q. Has the pressure retaining valve anything to do with applying the brake or admitting air into the cylinder?

A. No. It simply locks in the brake cylinder fifteen pounds of pressure.

Q. What difference is there between the improved pressure retaining valve shown by Fig. 37 and the old style retaining valve?

A. The old style pressure retaining valve had a slot extending through the key which frequently became inoperative. The new valve has a peripheral cavity extending more than half way around the key.

Q. What should be the position of the retaining valve?

A. It should always stand perpendicular as shown by Fig. 37. Both the valve and the pipe should be well secured and a good rubber placed on the union. A little flexibility should be provided in the pipe connecting this valve with the triple valve.

Q. Where should it be located?

A. It should be free of access while the train is in motion and with no obstruction to the removal of the cap. It is usually placed at the end of the car. On passenger coaches about level with the edge of the hood and on freight cars close to the brake standard.

Q. Why is it sometimes placed beneath the car?

A. To prevent the train crew from tampering with it if they think the engineer is descending a grade too slowly.

Q. Is a retainer used for other purposes than to steady a train while recharging?

A. Yes, a few are sometimes used when brakes have been applied too hard to keep the slack bunched after releasing when drifting along preparatory to making a stop.

Q. Should the retaining valve be oiled?

A. No, but it should be cleaned every time the other parts are cleaned.

Q. What will cause the retaining valve to be inoperative when it is cut in for service?

A. A leak in its pipe connections—frequently the union—ports plugged up, or a leak in the brake cylinder or in the retaining valve, but seldom the latter. Mr. Brees says: "If brakes stick frequently trouble will be found in the port holes; dirt will collect or sometimes insects will make nests in them, which we have found to be the case."

Q. Is it important that the train crew should be familiar with the operation of this device?

A. Yes, it is very important, especially on mountain roads. It is a very simple device and easily kept in good working order. The train crew should examine the union in the pipe leading to it, frequently, for a very small leak will render it worthless.

THE HIGH-SPEED BRAKE.

Q. What is the high speed brake?

A. It is the ordinary air brake with the addition of a duplex governor, duplex feed valve attachments for the brake valve, the automatic pressure reducing valve for the brake cylinder, and it is operated by a much higher pressure than is ordinarily carried.

Q. On what class of trains is it used?

A. On fast passenger trains that are scheduled at about sixty miles per hour.

Q. When is the high pressure used in applying the brake?

A. In all emergencies.

DIAGRAMMATIC ILLUSTRATION OF THE WESTINGHOUSE STANDARD HIGH-SPEED BRAKE.

PLATE 3.

Q. Is there no danger of sliding wheels when using this type of brake in emergencies?

A. Not at high speeds.

Q. Why can this brake be used in emergencies, at high speeds, without sliding wheels?

A. Because the pressure developed in the air brake cylinder is automatically reduced as the speed of the train reduces. And at high speeds the friction is not so great between the brake shoe and wheel as at low speed.

Q. How is the automatic reduction of pressure in the brake cylinder accomplished?

A. By means of the automatic pressure reducing valve.

HIGH-SPEED BRAKE AUTOMATIC REDUCING VALVE.

Q. Describe the high pressure automatic reducing valve?

A. It is a slide valve having a triangular port in its face (the seat having a slot shaped port) and has a piston and adjusting spring, generally adjusted to resist a pressure of sixty pounds per square inch, and a body casting to enclose these parts.

Q. How does the pressure reducing valve operate?

A. When the brakes are applied with an emergency application, the pressure obtained in the brake cylinder being much higher than sixty pounds, forces the piston downward com-

HIGH-SPEED BRAKE AUTOMATIC REDUCING VALVE.

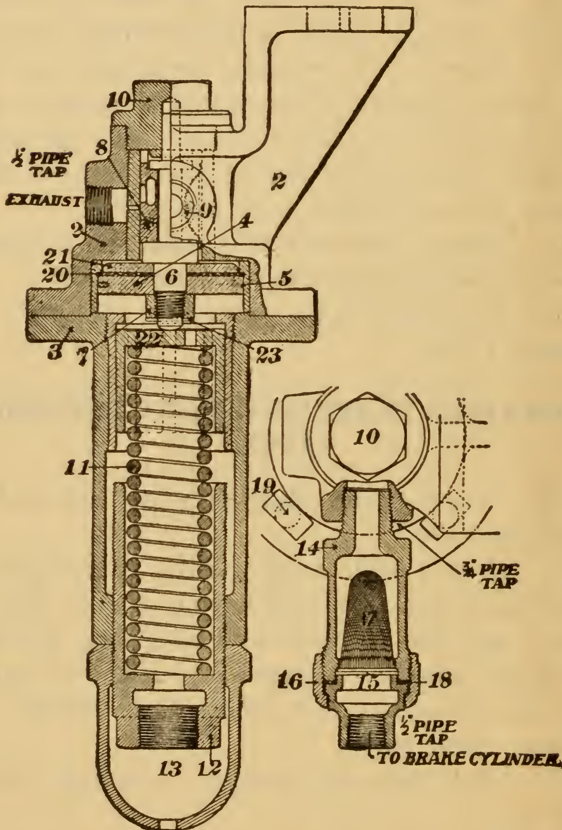


Fig. 38.

HIGH-SPEED BRAKE AUTOMATIC REDUCING VALVE.

2	Valve body.	13	Check nut.
3	Spring box.	14	Union stud.
4	Valve piston.	15	Union swivel.
5	Packing ring.	16	Union nut.
6	Piston stem.	17	Union strainer.
7	Piston stem nut.	18	Union gasket.
8	Slide valve.	19	Bolt and nut.
9	Slide valve spring.	20	Leather washer.
10	Cap nut.	21	Piston disc.
11	Regulating spring.	22	Spring abutment.
12	Regulating nut.	23	Cotter pin.

pressing the spring under it and moving the slide valve to a position where it will just uncover the apex or small port of the triangular port in its seat. As the pressure in the brake cylinder reduces, the compressed spring forces the piston and slide valve upward opening the triangular port wider and wider until the pressure reduces to sixty pounds, when the slide valve will have returned to its normal position and have closed the port, thus holding the pressure in the brake cylinder at sixty pounds.

Q. When the automatic pressure reducing valve opens where does the air escape to from the brake cylinder?

A. To the atmosphere.

Q. How is the high-pressure obtained in the brake system?

A. By simply turning a stop cock in the air pipe leading to the low pressure top of the pump governor. And by cutting out the low pressure feed valve, and cutting in the high pressure feed valve, on the brake valve.

Q. In the event of a car, not equipped with an automatic pressure reducing valve, being taken into a train that had the high speed apparatus in operation, what provision should be made to prevent the danger of sliding wheels?

A. It should have an ordinary pressure reducing valve, to retain sixty pounds pressure adjusted, screwed into its brake cylinder. Mr. Brees says the above answers should read as

SAFETY VALVE.

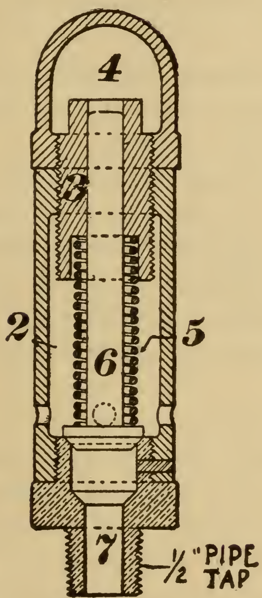


Fig. 39.

follows: "A safety valve screwed into brake cylinder adjusted to retain a pressure of fifty pounds."

HIGH PRESSURE CONTROL.

Q. What is meant by high pressure control?

A. It is meant that a higher pressure is used than that ordinarily employed in operating air brakes.

Q. What change is necessary in the ordinary air brake apparatus in order to operate the brakes with high pressure?

A. There should be employed a duplex governor for the air pump and safety valves such as shown in Fig. 39 for the driver and the tender brake cylinders should be provided.

Q. What are the conditions in train service that make the use of the high pressure control necessary?

A. High pressure control is necessary on all freight trains where the cars are loaded to their full capacity, especially when the loaded weight of the cars is much greater than the empty weight, and on heavy down grades where a sufficient and reliable controlling force is absolutely necessary.

Q. In what kind of service is the high pressure control used?

A. For coal, iron and mineral carrying roads, when the cars are all loaded going one way and are empty going the opposite way, and on roads having steep inclines where the decending trains are loaded.

Q. Of what does the high-pressure consist?

A. As used with the Westinghouse equipment it consists of a duplex governor, a duplex feed valve attachment same as is used by the high speed equipment and safety valves shown in Fig. 39 for the driver and the tender brakes; as used with the New York air brake equipment it consists of a duplex governor, and the safety valves for the engine and tender brake cylinders.

Q. When it is desired to use the high-pressure control how is it cut in?

A. By simply turning a stop cock in the air pipe leading to the low pressure governor top. Turning the governor top cock back again cuts out the high-pressure control, and cuts in the ordinary pressure brakes.

Q. What pressures are used with the high pressure control brake?

A. Usually one hundred and ten pounds in the main reservoir and ninety pounds in the train pipe.

Q. What should the main reservoir capacity be for passenger engines? For freight?

A. Not less than forty thousand cubic inches for passenger and not less than fifty thousand cubic inches for freight engines.

Q. What are the proper sizes of auxiliary reservoirs for use with the various brake cylinders?

A. A 16 x 33-inch reservoir should go with a 14-inch brake cylinder; a 14 x 33-inch reservoir should go with a 12-inch brake cylinder; a 12 x 33-inch reservoir should go with a 10-inch brake cylinder, and a 10 x 25-inch reservoir should go with an 8-inch brake cylinder. Mr. Gesner says: "A 10 x 24-inch reservoir should go with an 8-inch brake cylinder."

Q. Give the weights of the cars for which the different sizes of brake cylinders are suitable?

A. A 14-inch brake cylinder should be used on a passenger car weighing 70,000 pounds or more; a 12-inch brake cylinder should be used on a car weighing from 50,000 pounds up to 70,000 pounds, a 10-inch brake cylinder should be used on cars weighing 30,000 pounds up to 50,000 pounds. Mr. Gesner says: "The above should read from 35,000 pounds up to 50,000 pounds and that tenders up to 35,000 pounds in weight require 8-inch brake cylinders and over 35,000 pounds weight require 10-inch cylinders."

THE AUTOMATIC SLACK ADJUSTER.

Q. What is the automatic slack adjuster used for?

A. It is used to take up the slack in the brake rigging while the train is running.

THE AUTOMATIC SLACK ADJUSTER.

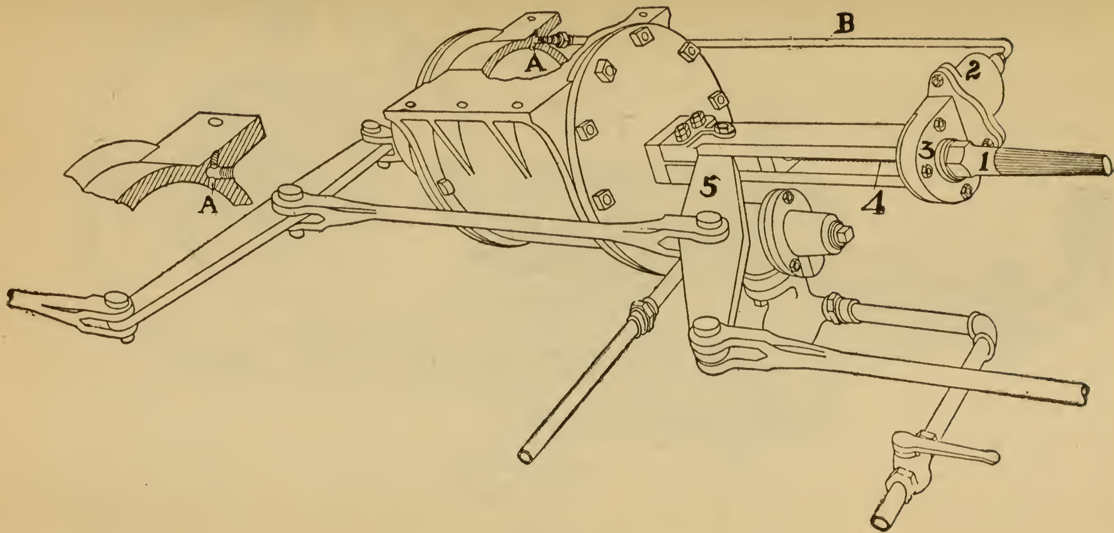


Fig. 40.

AUTOMATIC SLACK ADJUSTER.

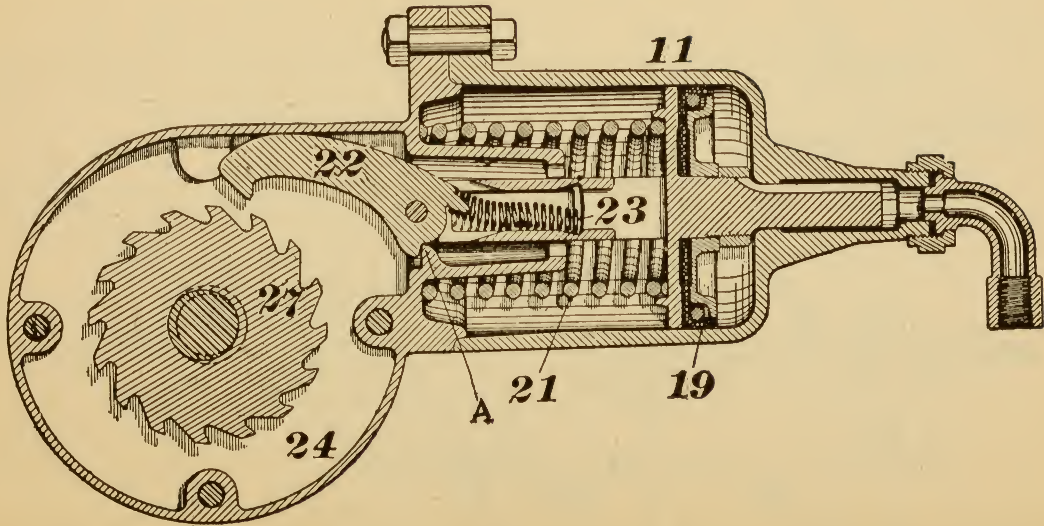


Fig. 41.

Q. Why is it better to take up the slack while the train is in motion?

A. Because this is the time the brakes do their work and it gives the correct piston travel. If the slack is taken up while the car is standing and the piston travel is adjusted it will not be the same when running.

Q. Why not?

A. There are many reasons. Under stress the brake shoes will pull down farther on the wheels, spring in the brake beams, boxes loose in the jaws, loose brasses on the journals, stress of the car bodies, or loose king bolts allowing the trucks to be drawn closer together; any or all of these causes effect the piston travel.

Q. How about loaded and empty cars. If the piston travel is adjusted when the car is loaded will it be the same when the car is light?

A. That depends entirely upon how the brakes are hung. If hung from the sand plank it will be the same, but if hung from the car body, as most brakes are, the piston travel will not be the same.

Q. Explain why.

A. The truck springs are compressed when the car is loaded and therefore the brake shoes hang lower on the wheel, when the car is unloaded the tension of the truck springs raises the car body brake beams and all the brake shoes will then stand higher and there will be less clearance between them and the wheels.

Q. What effect has this?

A. It shortens the piston travel, as the piston will not have to travel so far to bring the shoes up tight against the wheels.

Q. What is claimed for the automatic slack adjuster?

A. That a predetermined piston travel can be constantly maintained, compelling the brakes of each car to do their full quota of work—no more and no less—thus securing from the brakes their highest efficiency without the flat wheels which are likely to accompany a wide range of piston travel.

Q. Explain how the automatic slack adjuster operates?

A. A fair knowledge of the device may be had by studying Figs. 40 and 41. The brake cylinder piston controls the admission and release of air to the slack adjuster. A hole is drilled into the cylinder at the point A as shown by Fig. 40 and is so located that the brake cylinder piston uncovers it when the desired piston travel is exceeded, admitting cylinder pressure into pipe B and thence to the slack adjuster cylinder 2 where the small piston 19 in Fig. 41 is forced outward compressing spring 21. Attached to piston stem 23 is a pawl extending into casing 24 which engages ratchet

LOCOMOTIVE-TRUCK BRAKE.

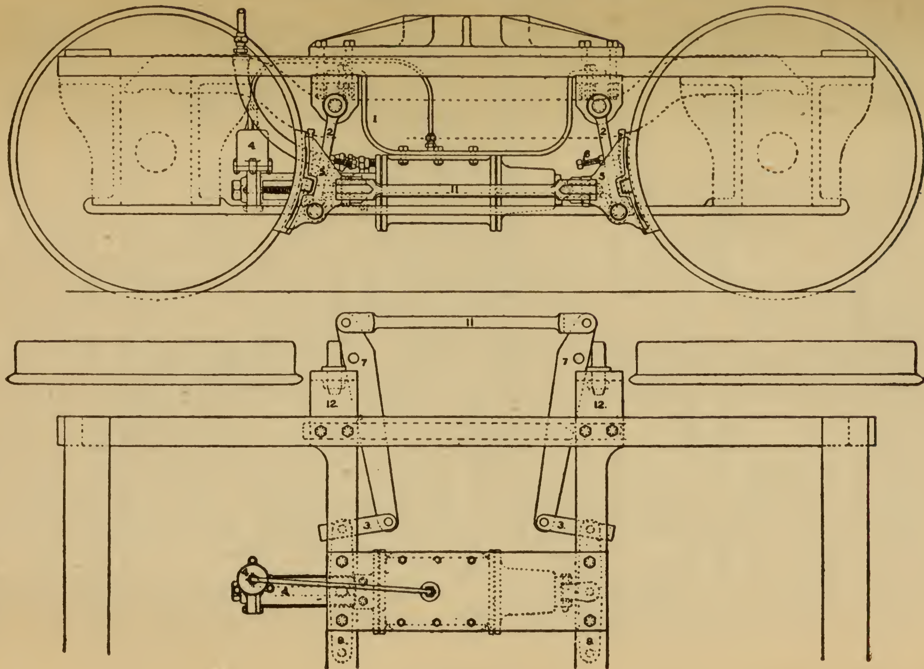


Fig. 42.

wheel 27, mounted within casing 24 upon screw 4.

When the brake is released and the brake cylinder piston returns to its normal condition the air pressure in cylinder 2 escapes to the atmosphere through pipe b, port A, and the non-pressure head of the brake cylinder, thus permitting spring 21 to force the small piston to its normal position. In doing so the pawl turns the ratchet wheel upon screw 4 and thereby draws lever 5 slightly in the direction of the slack adjuster cylinder, thus shortening the brake cylinder piston travel and forcing the brake shoes nearer the wheels.

Q. How much does this operation shorten the piston travel?

A. One thirty second of an inch each time.

Q. Can the piston travel be adjusted by hand with a slack adjuster applied to the car?

A. Yes. When the pawl 22 is pulled back it strikes the point A disengaging it from the ratchet wheel. A wrench may therefore be used at 1, Fig. 40, to adjust the screw 4.

Q. If the piston travel should become too short what may be the cause?

A. Some of the slack has been taken up by hand brakes where the two work together, or the dead levers have been moved.

Q. If the piston travel is found to be too long what may be the cause?

A. If the slack adjuster is found to be in

METHOD OF DRILLING BRAKE CYLINDER.

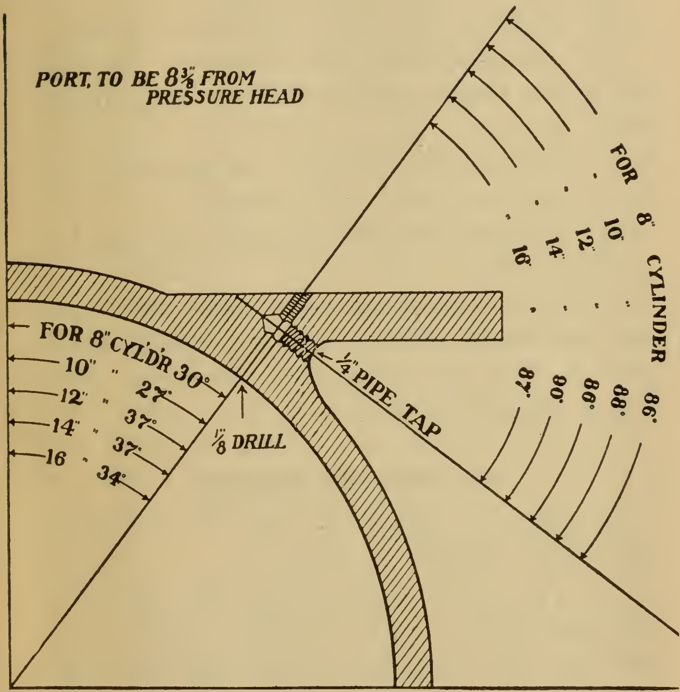


Fig. 43.

good working order it is more than probable that the slack has been taken up by an application and only partial release of the hand brake and subsequent full release after the brake shoes had worn more or less.

Q. What is shown by Fig. 43.

A. It shows how port A should be drilled.

Q. What kind of pipe should be used between the brake cylinder and the slack adjuster?

A. Copper pipe will give the best results as it is flexible and does not corrode.

Q. Should the slack adjuster be oiled, if so, how often?

A. Yes, it should be cleaned and oiled every time the brake cylinder is cleaned and oiled and after it has been cleaned it should be tested along with the brakes.

FOUNDATION BRAKES.

Q. What is meant by the term "Foundation Brake Gear"?

A. The brake rigging under the car, which comprises the brake beam, the brake levers, the pull and connecting rods, and the brake beam and shoes.

Q. How should a satisfactory foundation brake gear be designed?

A. It should be designed with a view to developing the correct braking force, and should be made sufficiently strong to resist all strains and shocks of service.

Q. How should the brake levers stand when the brake is applied?

A. They should stand at right angles to the line of force.

Q. How is the size of the brake cylinder suitable to use on a car determined?

A. By the per cent of the weight of the car which it is determined to use as braking force. Mr. Gesner says: "By the weight of the car when it is empty."

Q. About where is the best location for the brake cylinder?

A. The brake cylinder should be attached to the car body where it is accessible for repairs.

Q. How is it that such low pressure in the brake cylinder delivers so much higher pressure to the wheels of the car?

A. Because it is multiplied by the brake levers, which are mechanical devices for the advantageous application of the air.

Q. When we have a lever of which the proportions of the arms are known, how can the power that can be delivered at one end from a given force, applied at the other end, be determined?

A. By multiplying the given force by its distance from the fulcrum point, the length of the arm, and dividing the product by the distance of the power end from the fulcrum point—the other arm.

Q. What is the fulcrum point of a lever?

A. It is the fixed point about which the lever turns.

Q. About how much braking force should be used on a car?

A. The braking force on passenger cars should be about ninety per cent of the weight, and on freight cars, about seventy per cent of their light weight.

Q. From what brake-cylinder pressure as a base is the braking force for cars calculated?

A. From a brake-cylinder pressure of sixty pounds per square inch.

Q. It is stated that in emergency applications, the Westinghouse triples vent train-pipe air into the brake cylinders. How much will the vented train-pipe air augment the brake cylinder pressure?

A. The following table shows what can be gained in the brake cylinder, in emergency applications, from the vented train-pipe air, with the various sized brake cylinders.

TABLE.

	Service	Emergency	Per Cent.
14-inch Cylinder,			
6-inch stroke,	53 lbs.	56 lbs.	6
8-inch stroke,	51 lbs.	53 lbs.	5
12-inch Cylinder,			
6-inch stroke,	53 lbs.	58 lbs.	9
8-inch stroke,	52 lbs.	57 lbs.	10

	Service	Emergency	Per Cent.
10-inch Cylinder,			
6-inch stroke,	53 lbs.	58 lbs.	9
8-inch stroke,	52 lbs.	57 lbs.	10
8-inch Cylinder,			
6-inch stroke,	53 lbs.	60 lbs.	15
8-inch stroke,	50 lbs.	58 lbs.	17

Q. Why is it that there is a falling off in the percentage of increase in the brake cylinders, as the cylinder becomes larger in size, in emergency applications?

A. Because the volume of train pipe air remains substantially the same regardless of the size or weight of the car, and as a brake cylinder increases in size, of course it can not fill it to the same pressure that it would if the brake cylinder was small. Mr. Gesner adds: "All depends on the train pipe volume, it being greater in long than on short trains."

Q. What would be the effect on the wheels of a car if more braking force than that stated above was applied?

A. It would cause the wheels to slide.

Q. What would the effect be if less braking force than that stated above was used?

A. The brakes would not be applied with all the pressure they could stand, and then the stop could not be made in so short a distance as if the proper braking force was used.

Q. Does a wheel that is sliding while the brakes are applied have as great a retaining effect upon the train as one that is revolving?

A. No; a wheel that slides while the brake is applied does not retard or hold so well as one that revolves while the brake is applied.

Q. In making a road test of brakes when taking on cars or changing engines what should be done?

A. Before coupling to the train the engineer should have full main-reservoir and train-pipe pressure pumped up on the engine, so as to be able to charge the train without unnecessary loss of time. It is well when coupling the engine to the train, if it is necessary to release the brakes, to return the handle of the brake valve to lap immediately after making the first release just before coupling. (Mr. Dickson says: "With New York triple I advise you to re-apply brakes to prevent any danger of emergency from carelessness of trainmen opening angle cock, as New York triples will not go into emergency if applied light." In addition to this when the engine is coupled to the train "blow water out from tender train pipe and dirt from the hose".) When the engine is coupled to the train, the angle cock on the rear end of the tender should be opened first so that the hose connections may be charged up before the angle cock on the car is opened. To charge the train the engineer should leave the handle of the New York brake valve in full release position, and the handle of the Westinghouse brake valve in the running position.

Q. What is meant by charging the train?

A. When we speak of charging the train we mean filling the train pipe and auxiliary reservoir with air pressure.

Q. With the train-pipe pressure at seventy pounds, how long should it take to charge an auxiliary reservoir?

A. About one minute; on account of the size of the charging groove it cannot be done in less time.

Q. About how long should it take to charge a train from zero to seventy pounds?

A. The time required to charge a train depends on the number of cars composing it, capacity of main reservoir, size and efficiency of air pump.

Q. About how much pressure should be obtained before testing the brakes?

A. About sixty pounds in order to ascertain the piston travel, but maximum pressure is better, and should be obtained before testing, if time will permit.

Q. How should brakes be applied for the test?

A. They should be applied with a service application of about twenty pounds reduction.

Q. By whom should the test application be made?

A. By the engineer, if possible; whenever he is unavoidably absent, as when called to the telegraph office to sign orders, it may be made by the fireman, who should be competent to perform this service. Mr. Davis says: "Always by the engineer who is held responsible."

Q. After the brakes are applied for the test what should be done?

A. They should be carefully inspected to see that all brake shoes are against the wheels and that all brake pistons have the proper travel.

Q. After inspecting the brakes what should be done?

A. They should be released and again carefully inspected to see that all have released properly. After the second application, a report of the number of air brakes working and their general condition should be made to the engineer.

Q. How should the slack in brake rigging be adjusted?

A. By closing the cut out cock in the branch pipe, bleeding the auxiliary reservoir, and then adjusting the slack by means of the truck dead lever. After the slack has been properly adjusted, the brake should be cut in.

Q. Why should the brake be cut out before commencing to adjust slack or make any repairs to it?

A. Because if it is not cut out, there is danger of it applying automatically, and the person making the adjustment might, in consequence, be injured.

Q. How should the brakes be released after making a test application?

A. By placing the handle of the brake valve in the full release position until all brakes have had sufficient time to release, then returning it to running position.

Q. How often should the brakes be tested?

A. The brakes should be tested every time any change has been made in the make-up of the train, and if the train has been required to take the siding for any considerable length of time it should be tested before again taking the main track.

Q. When should a running test be made?

A. A running test of the brakes should be made when approaching railroad crossings, and meeting points on single track, a sufficient distance back from these points to insure that all brakes are holding properly. Mr. Dickson adds: "Also for all drawbridges, derailing switches, steep grades, etc."

Q. What is the proper adjustment for piston travel?

A. On freight cars the piston travel should never be less than five inches or more than seven inches, and on passenger equipment it should not be less than five and one-half inches or more than eight inches. On engines the driver brake pistons should travel not more than four inches, (Mr. Gesner says five inches) and the tender brake piston not more than seven inches. With the exception of the driver brake piston, all should be adjusted to as near six inches as it is possible to get them. Mr. Dickson adds: "Our standard is four to eight inches on freight cars and tenders and seven to nine inches on passenger. Most passenger brake piston travel cannot be made less than six inches. Driver brake pistons should travel not more than two-thirds the diameter of the brake cylinder or less than one-third its diameter." Mr. Brees says: "It seems to me something should be said regarding piston travel on compound engines. With these engines owing to the retarding force of the large cylinders (low pressure) we never shorten the travel here less than seven inches. If less at low speeds you are very liable to slide driving wheels. Shorter travel will do on simple engines."

Q. What effect does excessive piston travel have on the pressure developed in the brake cylinder?

A. It weakens it, and consequently makes the brake less powerful.

HANDLING TRAINS.

Q. In making an ordinary stop, how much pressure should be reduced from the train pipe at the first reduction?

A. From four to eight pounds. Mr. Gesner says: "Six to eight pounds, or five pounds

AMERICAN EQUALIZING DRIVER BRAKE.

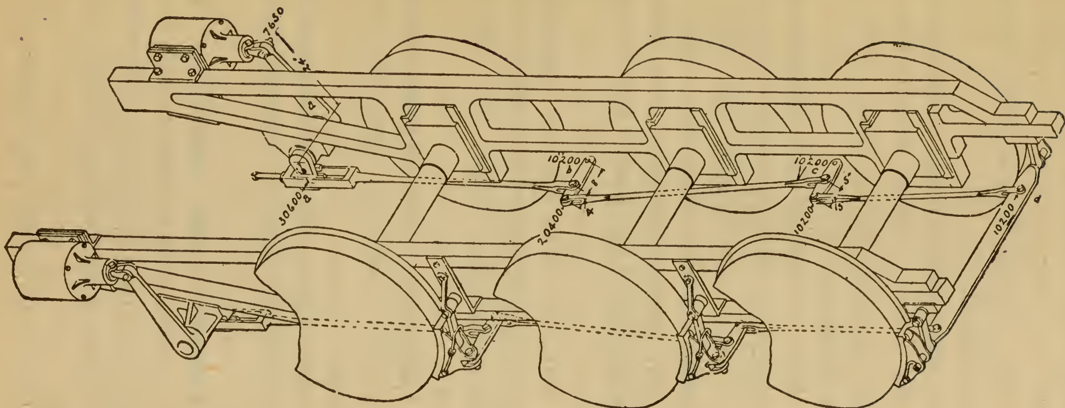


Fig. 44.

with thirty cars or less; if over thirty cars eight pounds."

Q. Why should this amount be reduced at the first reduction?

A. So that sufficient air may go through to the brake cylinder from the auxiliary to force the brake pistons beyond the brake cylinder leakage grooves.

Q. Why not make the initial train pipe reduction heavier than from four to eight pounds?

A. A heavier initial train pipe reduction than that specified would cause too heavy an application and might possibly cause shock to the train, especially if the piston travel was not uniform.

Q. After the first four or eight pounds reduction, how much pressure should be reduced from the train pipe at any one subsequent reduction?

A. The amount depends upon circumstances; but generally about four pounds will be found satisfactory.

Q. How many applications should be used for the ordinary station stop with a passenger train?

A. Generally two; sometimes where the track is level and the station platform long, the stop may be made with one application.

Q. What is meant by an application of the brake?

A. From the time the brakes are first applied until they are released; no matter how many reductions in train pipe pressure may have been made, is an application.

Q. Why should two applications of the brakes generally be used in stopping passenger trains?

A. It insures accuracy in making the stops, prevents sliding the wheels and permits brakes to remain applied until the train stops without causing a disagreeable shock, due to the recoil of the trucks. Mr. Roach says: "The brakes on passenger trains should be released in all cases just before stopping to avoid the jar."

Q. Should the brakes be held applied on a passenger train while standing at a water tank or coal chute?

A. It is considered a wise thing in passenger service to leave the brakes applied while standing at a water tank or a coal chute.

Q. How should a two-application stop be made with a passenger train?

A. The first application should be made a sufficient distance from the stopping point and with a sufficiently heavy reduction in train pipe reduction to stop the train, if allowed to remain applied, some distance short of the stopping point; then move all the triple valves to the release position, by placing the handle of the brake valve in full release position, then returning the handle immediately to the lap position, and when the engine is within a few car lengths of the stopping mark, make the second application when necessary. The point to be observed is, that in lapping the handle of the brake valve immediately after the release of the first application, the auxiliary and the train pipe pressure are held equal, and are lower than at the first application, and that you make the second application a prompt and light one.

Q. What is meant by overcharging the train pipe?

A. It is meant that for a short space of time after handle of the brake valve is placed in the full release position, the volume of main-reservoir air, so suddenly thrown into the train pipe, raises the pressure therein considerably above that in the auxiliaries, and while the train pipe pressure is higher than the auxiliary, the train pipe is said to be overcharged.

Q. What is the effect of overcharging the train pipe?

A. It hastens the recharging of the auxiliaries, and retards the application of the brakes in the service application, should such an application be desired during the time that the train pipe was overcharged.

Q. When but one application of the brake is made to stop a passenger train, when should the brakes be released?

A. Just before coming to a full stop, so as to avoid the disagreeable shock generally experienced when the train stops and the trucks straighten up.

Q. When approaching curves and while rounding them, when should the brake be applied, when necessary on such curves to steady the train?

A. It should be applied on the straight line just before striking the curve. Mr. Gesner adds: "And released before the curve is reached if circumstances will at all permit of it."

Q. In handling a freight train that is wholly, or only partly, equipped with air brakes, how should the application for an ordinary stop be made?

A. The initial reduction in train pipe pressure should be made heavy enough to move all brake pistons beyond the leakage grooves in the brake cylinders. The amount of reduction necessary to do this varies with the number of air braked cars in the train, being greater, the greater number of air brake cars. After the effect of the initial reduction is felt and the train has properly bunched, then the subsequent reductions may be made as speed, weight of train. holding power of brakes, grade etc., requires. Mr. Gesner says: "With trains of thirty cars or less, five pounds will be found to give the best results. Heavier reductions can be made corresponding to the number of cars over thirty."

Q. Should the brakes be released before the train stops, supposing it is seen that it will stop before reaching the desired stopping place?

A. As a rule, no. Mr. Gesner says: "And never if the speed is less than eight miles per hour." There are times and places when brakes may be released on freight trains before they come to a stop, but generally there is great danger of breaking the train in two, and the better practice is to stop the train, if the speed is anything slower than eight miles per hour, before releasing the brakes. Mr. Brees adds: "Ten miles per hour is better before releasing the brakes."

Q. What precaution should be taken if brakes are released when the train is moving slowly?

A. Care and judgment should be used to allow sufficient time for all brakes, both front and rear, to release before opening the engine throttle, and when the throttle is opened is should be only partly and carefully until the train is stretched again. To open the throttle immediately after placing the handle in full release position will almost invariably cause the train to part. Mr. Brees says: "If an engine is equipped with independent driver brakes they should be applied before train brakes are released. This will keep the slack bunched and prevent engine surging ahead when train brakes are released. After train brakes are released, release driver brakes. This I have found good practice."

Q. Why is it that it is recommended to hold the brakes applied on freight trains until they stop?

A. On account of the slack in the train; and on account of its great length, all the brakes cannot be released at the same instant. Mr. Gesner adds: "And because on freight trains the piston travel is never uniform."

Q. In backing freight trains out of sidings, the front cars of which have air brakes coupled up and working, how should the brakes be applied?

A. A few hand brakes should be applied on the rear, and as the engine passes the switch the air brakes should be applied carefully so as to prevent pulling the train apart when stopping.

Q. Should the engineer find that some of the wheels of the train are sliding, what should be the first thing to do?

A. If he can do so, he should release the brakes and before again applying, he should apply sand to the rail and keep the rail sanded until the stop is made. If the rail is bad, sand should be applied to the rail before the brakes are applied for any stops, and should be kept applied until the stop is made.

Q. If the wheels are sliding, will the application of sand to the rail start them to revolve again?

A. When wheels commence sliding the application of sand to the rail will not cause them to rotate again, but will cut large flat spots in them.

Q. In case brakes are applied with sufficient force to slide the wheels and an emergency should arise, should sand be used?

A. Yes, in all cases of emergency sand should be used.

Q. How can the cause of wheel sliding be investigated and ascertained?

A. If the brakes release properly from the engine, they should be applied to ascertain the piston travel. If the piston travel is correct on all cars then the leverage should be calculated to ascertain if too much power is being developed by it.

Q. How should the brakes be operated on trains while descending long heavy grades?

A. As soon as the train has pitched over the summit of the grade and commences to acquire momentum, a light service application of the brake should be made to maintain the speed at the safe limit. When releasing the brake either for the purpose of recharging the auxiliaries or for allowing the speed of the train to increase, advantage should be taken of all "let-ups".

Q. Why should the brakes be applied promptly after passing the summit of the hill and when descending a grade?

A. So as not to allow the train to acquire too great momentum. The secret of letting a train down a long steep grade safely, lies in not allowing it to get too much start at the top.

Q. While recharging auxiliaries on descending grades where should the handle of the brake valve be carried?

A. In full release position, until ready to reapply, unless full train pipe pressure has been accumulated before necessary to reapply, when it should be moved to the running position.

Q. In descending grades, is it desirable to maintain a uniform rate of speed?

A. Yes, where practicable, but the most important consideration is safety, and this consideration takes precedence over all others.

Q. Are there any specified rules for handling trains on down grades?

A. Very few. The steepness of the grade and the conditions existing must determine the best method to be adopted.

Q. In the event of a train, partly equipped with air brakes, parting between the air brake cars, what should be done by the engineer?

A. Close the throttle valve immediately, and place the handle of the brake valve on lap position.

Q. Is it good practice to attempt to pull the head end away from the rear end to prevent the separated parts of the train from coming together?

A. No. Attempting to keep the front part of the train away from the rear part would increase the distance between the sections for a moment only, then the brakes on the front portion will slow it down, so that the rear portion will run into it; and the force of the collision will be greater than if no attempt had been made to keep it out of the way of the rear end.

Q. When the train is recoupled after breaking in two, is it advisable to bleed off the rear brakes in case they should refuse to release?

A. They should be released by the engineer from the engine. However, if circumstances are such that considerable delay would result to other trains, it is better to release the rear brakes by opening the release valves, and after getting in motion make a running test to determine the holding power of the brakes.

Q. When two or more engines are coupled together, as in double-heading, which engineer should operate the brakes?

A. The engineer on the leading engine.

Q. What should the other engineers do?

A. They should close the cut-out cock underneath their brake valves, and run their pumps slowly but retain maximum pressure of seventy pounds.

Q. In case of an emergency where should the brake valve handle be placed?

A. In the emergency position, and it should be kept in that position until the train stops or the danger is past.

Q. If the engineer had the brakes applied with a light pressure, such as would be used in going over "slow-order" portions of the track and then should be suddenly flagged, where should the handle of the brake valve be placed?

A. Unless the engineer can plainly see ahead a sufficient distance to understand the situation, he should place the handle of the brake valve in the emergency position.

Q. If the train is partly equipped with air brakes, and is flagged in a manner to indicate danger close ahead, should the engineer first endeavor to bunch the train before applying the brakes in emergency?

A. No; always in emergencies,—apply the brake in emergency application without consideration for the train.

Q. In case of emergency, should the engine be equipped with a driver brake in good working order, be reversed?

A. No; a driver brake in fairly good working order will hold better, that is, will retard the train more, than an engine reversed. Again an engine reversed, even with a poorly holding driving brake, will slide its wheels, and sliding wheels do not hold so well as those that revolve while brakes are applied.

Q. In case the brakes are applied from the rear by the conductor, using the conductor's valve, or on account of a hose bursting, what should be done with the brake valve handle?

A. It should be placed on lap position until a signal is received from the rear to release the brakes.

Q. Why is it necessary to place the handle of the brake valve on lap when the brakes apply from the rear?

A. To prevent the escape of main reservoir pressure and to provide for a prompt release of the brakes when the signal is given. In the case of the conductor applying the brakes, the handle should be lapped to prevent the release of the brakes, when the conductor's valve closes, as well as to save main reservoir pressure.

Q. How should the conductor's valve be operated when it is necessary to use it?

A. If it is an emergency, that requires its use, it should be opened wide and be kept open until the train stops. If it is a case in which the conductor cannot operate the train air signal or cannot communicate with the engineer by other means, and he wishes to stop the train, he should do so by opening the conductor's valve gradually, so as to make a service application, and not an emergency. In both cases be sure to close the conductor's valve before leaving it.

Q. Why is it necessary to hold the conductor's valve open until the train stops?

A. Because if it is closed before the train stops, and the engineer has not lapped the handle of the brake valve, the brakes will release.

Q. What does the conductor's valve do when it is opened?

A. It simply allows the train pipe pressure to reduce by escaping to the atmosphere, which is the essential thing to do to apply the automatic air brakes.

Q. Can the brakes be released by the conductor's valve?

A. No; they must be released from the engine by admitting main reservoir pressure to the train pipe or by opening the release valves on the auxiliary reservoirs.

Q. When brakes apply of their own account, what is generally the cause?

A. The cause is generally either a hose bursting or the train parting.

Q. In case hose bursts, and there are no extra hose available, what can be done to make the necessary repairs?

A. Remove the rear hose on the last car in the train, and put it in the place of the bursted hose.

Q. If the cross-over pipe should break, would it be necessary to shift the car to the rear of the train?

A. No; if the break is at the union of the cross-over with the train-pipe it may be plugged with soft wood; if between the stop-cock and triple valve, all that is necessary to do is to close the stop-cock.

Q. In passenger service is it necessary to shift a car to the rear of the train, if the train pipe bursts or is broken?

A. A car, with a broken train pipe is generally placed on to the rear of the train, although the break in the pipe might be temporarily repaired by placing a piece of hose over the broken or ruptured portion and winding it up tightly. Mr. Brees says: "I consider this wrong. Split pipe cannot be made tight and it might cause emergency in a service application."

Q. When a car is placed on the rear of the train, owing to a defective brake, how should it be coupled up?

A. The air hose should be coupled, and the angle cock on the car ahead of it opened so as to permit the air to charge the hose, and the front angle cock on the car with defective brake should be closed.

Q. When it is necessary to assist the engineer with hand brakes to hold the train, which hand brakes should be applied?

A. Those next to the air brakes.

Q. Why not use the hand brakes on the rear of the train?

A. Because if the rear hand brakes were applied there would be a likelihood of breaking the train in two, especially if the engineer should release the air brakes.

Q. In setting out cars how should it be done?

A. The angle cocks on the front and the rear of the car, or the cars, to be set out should be closed first, and then the hose be parted by hand and properly hung up in the dummy coupling. After the cars to be set out are placed on the siding the air brake if applied, should be released and the hand brakes applied before leaving them. Many engineers claim this is seldom done, as it is easier for the brakeman to block the wheels.

Q. Why would it not be as well to set the hand brakes before releasing the air brakes?

A. Possibly on some freight cars the brake would be set too tight, and when the air brake was released the chain on the hand brake would be likely to break. On passenger cars, when the air brake released, or leaked off, the hand brake would also be off.

Q. Should the air brakes be depended upon to hold cars or trains while left to stand for any considerable length of time on a grade?

A. No; the air brakes should be released and the hand brakes applied. There is danger of the air brakes leaking off, and the train starting in consequence.

Q. How should the release valve be operated to release, or "bleed off" a brake?

A. The release valve should be held open until the air is heard to escape from the exhaust port of the triple, it should then be closed, as, if it is not, there is a likelihood of the brakes on the other cars applying.

Q. When cars are taken on at any station that have the air brake cut out, should the brakes be cut in and tried?

A. Yes; unless the brakes on them are easily seen to be out of order, cut them in and try them together with the others.

Q. When should the brake on a car be cut out?

A. When it is impossible to operate it satisfactorily.

Q. Are small leaks of sufficient importance to necessitate cutting out a brake?

A. No, it is only when leaks are so great that the pump cannot supply them that the brake should be cut out. Mr. Brees says: "Crews should try to keep up leaks."

Q. If there are throughout the train numerous leaks, varying in size, so that together the pump is unable to supply them what should be done?

A. The brakes having the largest leaks should be cut out. If the leaks are all about the same size, then the poorest brakes, care being taken, however, not to cut out more than three brakes in succession.

Q. Why should not more than three brakes in succession be cut out?

A. On account of the likelihood of quick-action not jumping the cut out brakes in the event of an emergency application, especially if the three successive brakes are close to the front end of the train.

Q. On coupling to a train that is already charged with air, how should the angle cocks be opened?

A. Always endeavor to form the habit of opening the angle cock nearest to the engine first after coupling the hose at any point in the train, and so guard against the danger of causing a quick action application of the brakes, which is very likely to result if the other angle cock is opened first, and air from the train allowed to rush into the empty hose to fill it.

THE TRAIN AIR SIGNAL SYSTEM.

Q. What is the train air signal used for?

A. To enable the conductor or train crew to convey signals to the engineer from the interior of any car in the train.

Q. Is the air signal system extensively used?

A. Yes; it is used upon passenger trains upon all first-class railroads.

Q. What means had a conductor at his disposal to signal the engineer before the air signal was invented?

A. A bell rope was used which was attached to a gong in the cab of the engine and it extended to the rear end of the train.

Q. What objections to the bell rope were there in passenger service?

A. Many; perhaps the most aggravating to the train crew was that tramps would frequently cut the bell cord near the front end of the train.

Q. Is the bell rope still in use?

A. Yes; it is still in use in passenger service on some small roads and it is extensively used upon fast freight trains upon many good roads.

Q. How does the conductor signal the engineer where the train air signal system is in use?

A. Each car is equipped with a cord or rope the length of the car,—one end of which is attached to a car discharge valve, located at the one end of the car which is connected to the signal line by a branch pipe. In order to signal the engineer he pulls on this rope. Air is thereby released from the signal line and the signal whistle in the cab notifies the engineer.

Q. Do both the Westinghouse and the New York air brake companies use an air signal system in connection with their equipment?

A. Yes, but the two systems are so nearly alike that it is unnecessary to describe both. To understand one, implies a knowledge of the other, the principal difference being in the signal valve. As there are more of the Westinghouse type in use we shall describe this system only.

WESTINGHOUSE.

Q. From where does the signal pipe receive its supply of air?

A. From the main reservoir.

Q. What does plate 4 represent?

A. It is a diagrammatic illustration of the general arrangement of the various parts of the train air signal system. The location of the parts may be changed if found convenient, so long as the pipes are properly connected.

Q. Name the essential parts of the air signal system.

A. A reducing valve—a signal valve, a whistle, the car discharge valve and the signal line and couplings similar to the train pipe.

Q. What is the reducing valve used for?

A. To prevent full main reservoir pressure entering the signal line. When the required pressure has been admitted, the reducing valve automatically closes communication with the main reservoir and when the signal line pressure has been reduced from any cause, the reducing valve will again admit air from the main reservoir until the required pressure has been obtained.

Q. What pressure is carried in the signal line?

A. Usually forty pounds.

IMPROVED REDUCING VALVE.

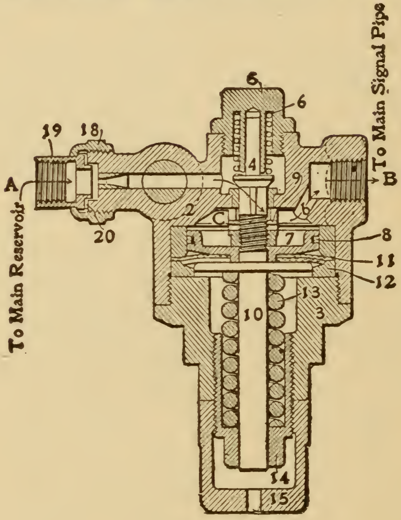


Fig. 45.

Q. Explain the operation of the improved reducing valve.

A. This valve is shown by Fig. 45. The numbers 7 and 10 are the reducing valve piston and stem which are forced upward by the spring 13 which is adjusted by the nut 14 to the pressure desired to carry in the signal line. Supply valve 4 is moved off its seat by the stem of piston 7. Main reservoir pressure is admitted at A and passes under valve 4 into chamber C, thence out at B into the main signal pipe. When the pressure in cavity C overcomes the tension of spring 13, the piston 7 and stem 10 are forced downward and the small spring 6 forces valve 4 onto its seat, thereby cutting off main reservoir pressure. The pressure in cavity C and the signal line is always the same. Therefore, when the pressure in cavity C is reduced from any cause, such as a reduction at the car discharge valve or from leaks or otherwise, the spring 13 will force piston 7 upward and unseat the supply valve 4 and recharge the signal line.

AIR SIGNAL SYSTEM DETAILS.

Q. If the reducing valve needed repairs how could it be done without loosing main reservoir pressure?

A. A stop-cock is usually placed between the main reservoir and the reducing valve.

Q. What is the best location for the reducing valve?

A. Inside the cab, as it will prevent freezing up in winter.

Q. What were the defects of the old style reducing valve?

A. It would not feed leaks quick enough and would frequently cause a continuous blowing of the signal whistle.

Q. Are many of these valves still in use?

A. Yes, a great many.

Q. Describe the operation of the old style reducing valve.

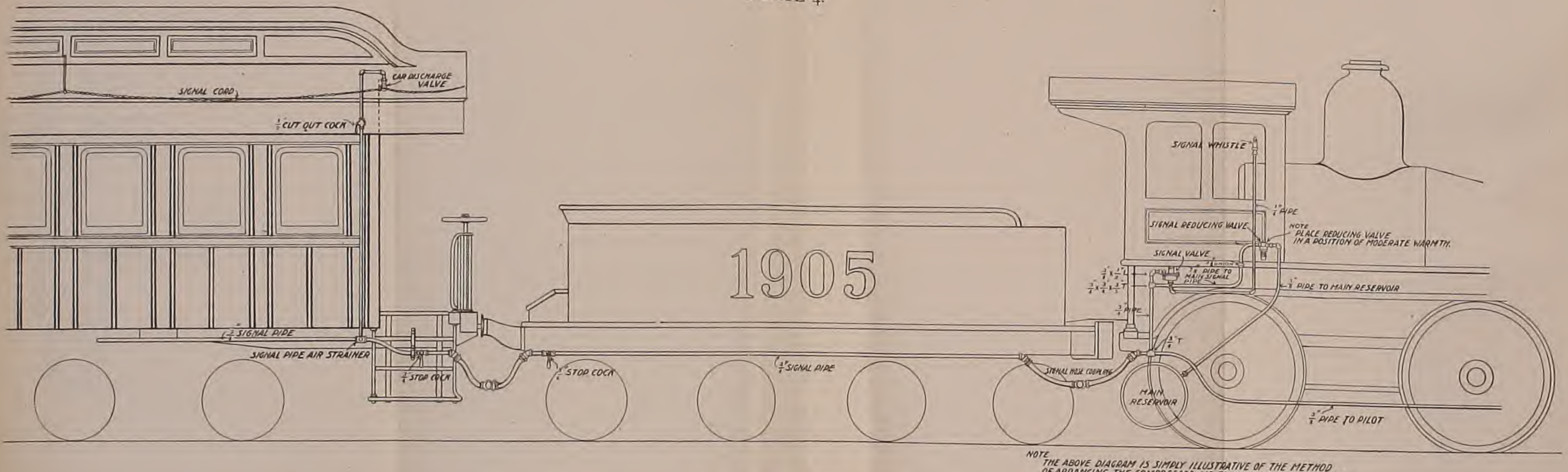
A. This form of valve is shown by Fig. 46. Spring 9 is adjusted to the required whistle train line pressure, its tension forcing downward upon diaphragm 7, which in turn forces the supply valve off its seat, permitting main reservoir pressure to enter at Z, pass through the chamber A and out at Y into the signal line. When the pressure in cavity A is sufficient to compress the spring 9, then spring 10 will force valve 5 onto its seat and thereby cut off main reservoir pressure. When the whistle signal line is reduced the tension of spring 9 will again unseat valve 5 and admit main reservoir pressure.

Q. How would you increase or decrease signal line pressure with the improved reducer?

A. By adjusting nut 14 up or down—up to increase and down to decrease it.

Q. How with the old style reducer?

PLATE 4.



NOTE
THE ABOVE DIAGRAM IS SIMPLY ILLUSTRATIVE OF THE METHOD OF ARRANGING THE COMPRESSED AIR TRAIN SIGNALING APPLIANCES, AND MAY BE MODIFIED AS THE CONSTRUCTION OF THE ENGINE DEMANDS.

AIR SIGNAL EQUIPMENT.

OLD-STYLE REDUCING VALVE.

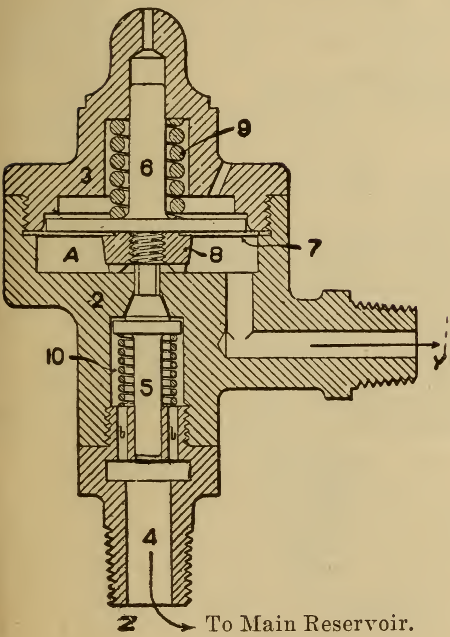


Fig. 46.

A. Apply a new spring or place a washer under the old one.

Q. What are the duties of the signal valve?

A. The signal valve releases the air that blows the signal whistle in the cab.

Q. Where is the signal valve located?

A. Usually under the foot board. It may be located on either side of the engine, as convenience may suggest.

Q. Describe the operation of the signal valve?

A. The signal valve is shown by Fig. 47. It is divided into two compartments, A and B, which are separated by diaphragm 12, to which is attached the stem 10; the lower end of stem 10 forms an air tight seat on the bushing 7. This stem 10 fits bushing 9 snugly for a short distance below its upper end to where a peripheral groove is cut in the stem. This fit in bushing 9 is not tight, but sufficiently so to allow air to feed through it very slowly. Below this groove the stem is three-sided. The signal pipe air enters the signal valve at Y, passing through the small port d into chamber A, thence through port C and slowly into chamber B until the pressure in both chambers A and B are equalized. Any sudden reduction of pressure in the signal line, such as the conductor signaling the engineer, or a parted train, reduces the pressure in chamber A, and the unreduced pressure in chamber B forces the

SIGNAL VALVE.

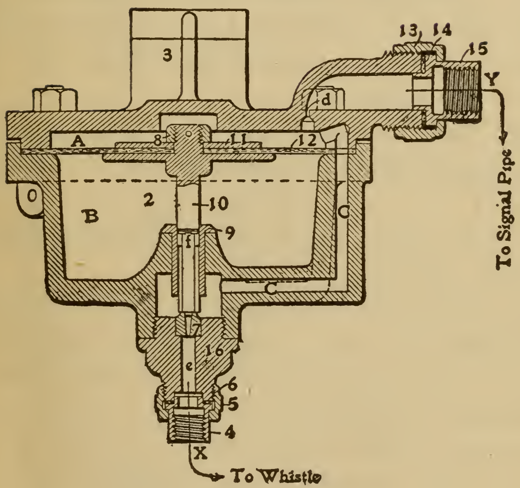


Fig. 47.

diaphragm and its stem upward, which uncovers the port e, thereby permitting air to escape at X, which sounds the whistle in the cab, but it will blow for an instant only until the pressure again equalizes in chambers A and B and the end of stem 10 closes port e.

Q. How long does it take for chambers A and B to equalize?

A. Ordinarily about two seconds, but it is safer for the conductor to wait three seconds before making a second reduction and even more if a long train.

Q. What would occur if a second reduction were made before chambers A and B had equalized?

A. It would cause one continuous blast of the air whistle.

Q. Must the reduction in whistle train line be sudden in order to operate the signal valve?

A. Yes; otherwise it would leak between bushing 9 and piston 10 so rapidly as to make the signal valve inoperative. It is the suddenness of the reduction that operates the signal valve.

Q. How does a reduction in the signal valve operate the reducing valve?

A. They are both connected with the signal line by independent piping, so it is impossible to cause a reduction in one without also causing a reduction in the other.

Q. How does the car discharge valve operate?

CAR DISCHARGE VALVE.

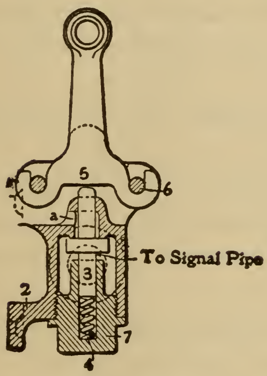


Fig. 48.

A. This valve is shown by Fig. 48. The signal cord is attached to the end of lever 5 and each pull upon the cord forces valve 3 off its seat and permits air to escape at port a, which reduction, as has been previously explained, will cause a blast of the air whistle in the cab.

Q. Where is the car discharge valve located?

A. At one end of the car on line with the bell cord. It should be outside the car, although many are located in the saloon inside of the car.

Q. Why should it be placed outside of the car?

A. So that the noise caused by the discharge of air will not affect sick or nervous passengers.

Q. Where are the signal air strainers located?

A. They should always be located upon the car as shown by Plate 4, and sometimes between the main reservoir and the reducing valve.

Q. If there is a constant leak at the discharge valve what is the trouble?

A. There is dirt on the seat of valve 3.

Q. If no air escapes from the discharge valve after the cord has been pulled what is the cause?

A. It is probable the cut-out cock in the saloon is shut off.

Q. After coupling an engine to a train it is found that the signal line is not charged, where would you look for the trouble?

A. First examine the angle cock between engine and train and be sure it is open. Next examine the plug cock between the main reservoir and reducing valve, and if the reducing valve is outside and the weather is cold it may be frozen, or it may be that the small taper port in the reducer, Fig. 45, where main reservoir pressure enters, may be closed with dirt or oil.

Q. Name the other defects that would make the signal system inoperative.

A. In the signal valve too loose a fit between stem 10 and bushing 9 (Fig. 47), or a baggy diaphragm or one with a hole in it or the small port d being plugged up, dirty strainers or an improperly adjusted whistle bell, and too slow a reduction made in the signal line.

Q. Why would too loose a fit between bushing 9 and stem 10 prevent the whistle sounding?

A. Chambers A and B might equalize without raising the diaphragm, especially if the reduction were made slowly.

Q. Why would the signal whistle not sound with a baggy or worn-out diaphragm?

A. Because when a reduction was made in chamber A the pressure in chamber B would cause the diaphragm to bulge upward, but would not raise stem 10 from its seat.

Q. How would a hole in the diaphragm 12, Fig. 47, prevent the whistle from sounding?

A. Because air would flow from chamber B directly into chamber A until the pressure equalized and would not raise stem 10.

Q. If the small port d, Fig. 47, is plugged up, how will it prevent the whistle from sounding?

A. Because when a reduction is made in the signal line no air can escape from chamber A.

Q. What is the effect of dirty or plugged up strainers?

A. When the conductor pulls the signal cord no air will escape at the car discharge valve.

Q. What will cause the whistle to sing continuously?

A. Dirt on the seat at the bottom of stem 10, Fig. 47.

Q. What may cause the whistle to blow intermittingly?

A. Jars. The diaphragm in the signal valve sometimes becomes baked with oil and may jar stem 10 from its seat.

Q. What effect has an improperly adjusted signal whistle bell?

A. Whistle bells are usually adjusted to such a height from the bowl as will furnish the clearest and most distinct sound with a given pressure. If improperly adjusted the whistle may shriek or not sound at all.

AIR WHISTLE.

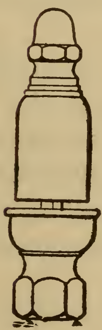


Fig. 49.

Q. What effect has too slow a reduction?

A. The friction of the air passing through the pipes tends to decrease the suddenness of the reduction, especially if the train be a long one, which allows too much time for the air to pass by bushing 9 and piston 10, Fig. 47, thereby permitting chambers A and B to equalize without raising stem 10.

Q. If spring 13 of the reducing valve, Fig. 45, be properly adjusted to forty pounds pressure, how can full main reservoir pressure enter the whistle signal line?

A. If there is dirt on the seat of valve 4, Fig. 45, which prevents the valve from seating, full main reservoir pressure will leak past valve 4 and back into the signal line.

Q. What effect will ninety pounds pressure have upon the signal whistle in the event of a reduction?

A. It will cause the whistle to screech.

Q. What other effect may this main reservoir pressure in the signal line have?

A. The signal whistle will blow when the brakes are released, especially if the train is short.

Q. What causes the whistle to blow in this case?

A. In order to release the brakes main reservoir pressure must be thrown into the train line and as the main reservoir pressure is reduced the ninety pounds pressure in the signal line will flow under valve 4, Fig. 45, toward the main reservoir and the reduction in signal line pressure will cause the whistle to blow.

Q. Why is the whistle more likely to sound on a light engine when the brakes are released?

A. Because if coupled to a train there would be a greater volume in the signal line and the reduction would not be so great.

Q. Sometimes the whistle will blow two or three times with one reduction. What is the cause?

A. The fit between bushing 9 and stem 10, Fig. 47, is too loose and there is main reservoir pressure on the signal line. When a reduction is made it starts the signal valve to operate and the reducer cannot feed air into the signal line properly to cause the signal valve to close until the pressure in the signal line is forty pounds or less. Meanwhile the pressure in chambers A and B fluctuate, which causes the diaphragm to raise and lower several times which uncovers port e of the signal valve permitting air to escape to the whistle.

Q. What may cause one long blast of the whistle?

A. Reduction made too rapidly or too tight a fit between bushing 9 and stem 10 in the signal valve.

Q. How may an engineer ascertain what pressure he has in the signal line?

A. Have the fireman bleed the main reservoir until the whistle blows and watch the red hand which will register slightly less than signal line pressure when the whistle blows. The reason of this is that when main reservoir pressure falls below signal line pressure the air will flow toward the main reservoir and cause a reduction of pressure in the signal line which will cause the whistle to blow.

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